Assisted Migration: Redefining Nature and Natural Resource Law Under Climate Change

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To avoid extinctions and other harms to ecological health from escalating climatic change, scientists, resource managers, and activists are considering and even engaging in "assisted migration"—the intentional movement of an organism to an area in which its species has never existed. This Article explores the profound implications of climate change for American natural resource management through the lens of this controversial adaptation strategy. It details arguments regarding the scientific viability and legality of assisted migration under the thicket of laws that govern natural resources in the United States. The Article asserts, however, that the fundamental tensions raised by this strategy are ethical: to protect endangered species or conserve native biota; to manage ecological systems actively or leave nature wild and uncontrolled; and to preserve resources or manage them to promote their fitness under future conditions.

The Article explains why contemporary natural resource law's fidelity to historic baselines, protecting preexisting biota, and shielding nature from human activity is increasingly untenable, particularly in light of climate change. Active, anticipatory strategies such as assisted migration may not only be permissible but even necessary to avert substantial irreversible harm to ecological systems. Scientists and resource managers should focus on developing scientific data to aid analyses of the risks and benefits of assisted migration in particular circumstances. To help develop such data while minimizing ecological harm, the Article proposes provisionally limiting experimental translocations to situations where translocation is technically

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and economically feasible, and where the species is endangered, ecologically valuable, and compatible with the proposed site.

More broadly, assisted migration illustrates how the institutions and goals of natural resource law must be changed to better reflect a dynamic, integrated world. Climate change forces a radical reconsideration of the aims, foci, and standards of natural resource management. Accordingly, the crucial project of natural resource law must be improving governance by cultivating agency accountability and learning to better manage uncertainty, promoting opportunities for interjurisdictional collaboration, and fostering public information and deliberation over the tradeoffs of strategies like assisted migration and the resource values that matter.

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Introduction

A growing number of conservationists, resource managers, and legal scholars are suggesting the use of an experimental and controversial strategy to help the world’s biota adapt to the considerable projected adverse effects of anthropogenic climate change. “Managed relocation,” alternatively dubbed “assisted migration” and “assisted colonization,” is the intentional transfer of flora or fauna to a new region in response to climatic change. In other words, assisted...
migration involves the deliberate movement of non-human refugees to a new area for which they are believed to be better suited due to projected changes in climate. Decisions on whether, when, and how to use this novel form of species translocation will undoubtedly have substantial consequences for biota and ecological systems. Yet such questions also make plain how climate change necessitates fundamental changes in American natural resource management.

Assisted migration is undoubtedly controversial, and has captured the imagination of the American and international popular press. Scientists are at odds over whether the uncertainties and potential ecological risks of assisted migration prevent it from being a scientifically viable conservation strategy. The thicket of fragmented state and federal laws in the United States that seek to manage invasive species, protect and recover endangered species, and otherwise preserve and restore public natural resources may allow assisted migration under narrow circumstances. Yet moving species outside their native range as a response to global change would be a fundamental shift in natural resource conservation.

Private parties and resource managers have previously engaged in translocation as an acute response to species decline from conventional environmental stressors. The U.S. Fish and Wildlife Service (FWS), for example, has translocated various endangered species as allowed under the federal Endangered Species Act. On the other hand, many effects of climate change... It involves the intentional movement of biological units from current areas of occupancy to locations where the probability of future persistence is predicted to be higher.


10 See infra Part I.
11 See infra Part II.
existing natural resource laws, management practices, and institutions focus on sheltering native areas, preventing the introduction of non-native species, and reversing the negative effects of invasions by non-native species.\textsuperscript{13} This approach is indicative of a broader resistance from natural resource managers and scientists to the intentional movement of biota (and, in particular, vulnerable species) to new non-native locations. Indeed, even under the species-focused ESA, very few endangered species have been moved outside their probable historic range, and even these cases have involved extenuating circumstances.\textsuperscript{14}

Nonetheless, assisted migration has been gaining considerable momentum. Despite controversy over its use, growing numbers of resource managers and scientists are recommending it as a necessary strategy to avoid species extinction due to climate change,\textsuperscript{15} and some proponents are already taking action. The Montana Fish, Wildlife & Parks Department has proposed the replacement of existing non-native trout in the Bob Marshall Wilderness with other non-native trout that the Department projects will be better adapted to future climate conditions.\textsuperscript{16} Torreya Guardians is a private group formed to protect \textit{Torreya taxifolia}, a plant listed as endangered under the ESA that exists mainly in small parts of Florida and Georgia where it no longer grows past the juvenile stage.\textsuperscript{17} They have already transplanted the plant outside its native range in Florida to North Carolina numerous times in 2008, claiming the moves are necessary to save the plant from the effects of climate change.\textsuperscript{18} British researchers have moved two common, generalist butterflies in England—the marbled white butterfly (\textit{Melanargia galathea}), and the small skipper butterfly (\textit{Thymelicus sylvestris}).\textsuperscript{19} Scientists from the Chicago Botanic Garden are collecting seeds of a wide range of rare species and are considering the possibility of transplanting such species to help them migrate to more favorable conditions as the climate changes.\textsuperscript{20} Some in

\textsuperscript{13} See infra Section II.B.
\textsuperscript{14} See infra Subsection II.A.1 for a detailed discussion of translocation efforts under the ESA.
\textsuperscript{15} See infra Part I.
\textsuperscript{16} See David N. Cole et al., \textit{Naturalness and Beyond: Protected Area Stewardship in an Era of Global Environmental Change}, 25 \textit{GEORGE WRIGHT F.} 36, 42 (2008).
\textsuperscript{18} See Barlow & Martin, supra note 1, at 52-55. See generally Torreya Guardians, http://www.torreyaguardians.org (last visited Mar. 3, 2010).
\textsuperscript{19} See Willis et al., supra note 7, at 45.
Congress are considering funding for research on assisted migration, and the Ecological Society of Australia has already endorsed assisted migration when "appropriate." Yet even some proponents of using translocation as a strategy for responding to climate change are reticent to promote introductions of species to entirely new areas. Some who are already actively engaged in translocation stop short of promoting its use outside a species' native range, while others would limit its use to areas in the same biogeographic region. Still others rely on unsettled claims that a species proposed to be translocated is actually being returned to an area it inhabited long ago. Detractors of assisted migration meanwhile have decried it as tantamount to "ecological roulette," likely to cause more problems than it solves.

Why does the intentional movement of species to new places create such unease and stir such controversy? Though discussions in the press and scholarly literature have focused almost exclusively on its scientific viability and legal feasibility, this Article asserts that assisted migration is controversial because it challenges foundational tenets of conservation law and ethics that seek to preserve and restore preexisting biological systems and shield them from human interference.

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22 ECOLOGICAL SOC'Y OF AUSTL., CLIMATE CHANGE: POSITION STATEMENT BY THE ECOLOGICAL SOCIETY OF AUSTRALIA 4 (2009), available at http://www.ecolsoc.org.au/Position_papers/ClimateChange.htm (supporting, "if appropriate, translocation or assisted migration of key species threatened by climate change").
23 For example, researchers at the British Columbia Ministry of Forests and Range are planting seeds from fifteen species at forty-eight reforestation sites from central Yukon to southern Oregon to enable "researchers to identify the seed sources most likely to be best adapted to current and future climates." See Assisted Migration Adaptation Trial, http://www.for.gov.bc.ca/hre/forgen/interior/AMAT.htm (last visited Feb. 19, 2010). However, they are only moving the seedlings uphill within their historic ranges. See Marris, supra note 2, at 908 ("Another potential action would be moving species outside their historical ranges. Neither O'Neill in his AMAT nor forestry companies have gone that far; they are moving populations of trees around within their historical range.").
24 Hoegh-Guldberg et al., supra note 3, at 346 ("We are... advocating serious consideration of moving populations from areas where species are seriously threatened by climate change to other parts of the same broad biogeographic regions . . . .").
25 Barlow & Martin, supra note 1, at 54 (claiming that the North Carolina region to which Barlow and Martin propose relocating Torreya taxifolia was the endangered plant's historical habitat before the last ice age, even though the plant only currently exists in Florida).
26 Ricciardi & Simberloff, supra note 7, at 252.
27 See infra Section III.A.
management, including the protection of endangered species, the maximization of future ecological health, and active management to maintain and improve natural resources. Although these tensions have been simmering in natural resource policy, climate change greatly accelerates the pressure and exposes where accommodations of these tensions in existing law are problematic.

This Article contends that the existing regulatory framework's reliance on preservation and a human-nature dualism is outdated and unproductive in light of the pervasiveness of human interaction with what are inherently dynamic natural systems.\(^{28}\) Given the threats to biodiversity from climate change, assisted migration should not be categorically dismissed as a potential adaptation strategy by public regulators, scientists, and conservationists. Under certain conditions, assisted migration will be a reasonable and necessary approach to manage the effects of climate change.\(^{29}\)

More broadly, assisted migration exemplifies how climate change necessitates the reinvention of natural resource management to better reflect and manage a dynamic world.\(^{30}\) Natural resource law should focus on developing regulatory institutions that not only help regulators reduce uncertainty, but that also teach agencies how to better manage ecological change over time. Assisted migration makes evident, however, that global climate change prompts a public reconsideration of not only the means but also the ends of American natural resource law. By making the law's fixation on a static model of nature increasingly untenable, climate change requires a shift in natural resource management away from the preservation of native species toward maximizing desirable and minimizing undesirable change.

Drawing on insights from the scientific, ethical, and legal literature, this Article explores in five parts the numerous implications of managed relocation. Part I discusses the scientific viability of assisted migration as a strategy for adapting natural resources to climate change. Though assisted migration raises a number of ecological risks, not employing it to alleviate the effects of climate change does as well. Part II details the narrow circumstances under which the practice would be legally permissible under current federal and state law. It also explains how the wide-scale use of assisted migration would be antithetical to conventional natural resource law and management in the United States.

Part III then explores the normative concerns implicated by assisted migration. It presents arguments that assisted migration is an important

\(^{28}\) See infra Section III.B.

\(^{29}\) See infra Part IV.

\(^{30}\) See infra Part V.
strategy for protecting biodiversity from the harmful effects of climate change. It considers counterarguments that assisted migration would erode longstanding objectives of natural resource management that seek to promote historical preservation and restoration, protect native ecosystems, and safeguard wild nature from human intervention. Part III concludes that the regulatory structure, preservationism, and human-nature dualism of conventional natural resource management require rethinking. The accelerated effects of climate change on ecological systems show how dividing species between native and non-native is arbitrary and futile, and that preserving a historical, native baseline will be increasingly untenable. Moreover, climate change makes it especially evident that any attempt to bifurcate human and natural systems is impossible. Active management strategies such as assisted migration may not only be ethically permissible but even necessary to avert the harmful effects on ecological systems.

Accordingly, Part IV argues that assisted migration may be the best management alternative in some circumstances for promoting healthy ecosystems in light of the effects of climate change. It proposes a provisional framework for case-specific risk analyses of assisted migration, suggesting its use as an experimental adaptation strategy if translocation and management is technically and economically feasible and the species is endangered, ecologically valuable, and compatible with the proposed site. Part IV recommends a research agenda for substantiating these factors, emphasizing however that decisions on the appropriate weight of these and other factors are normative and will also require substantial public deliberation. Finally, Part IV argues that governing regulatory institutions should be designed not only to provide managers relevant scientific data, but also to help regulators manage uncertainty by learning about the efficacy of management strategies like assisted migration over time.

Perhaps the most profound revelation from an analysis of assisted migration, however, is the manner in which climate change calls into question the means and ends of natural resource management. Using assisted migration as a valuable illustration, Part V explains how climate change forces a radical reconsideration of the goals, focus, and management standards of conventional natural resource management. Legislatures must refashion natural resource management objectives and institutions to reflect the dynamism of natural systems. Objectives should include maximizing future ecosystem function rather than preservation; facilitating important ecological processes rather than blindly maintaining preexisting species; and determining the compatibility of an organism with future conditions at a site rather than based on whether it is native or natural. The Article concludes by suggesting that perhaps the most important challenge raised by climate change is procedural—how societies
should structure processes for formulating answers to the substantive challenges raised by a changing climate. By exposing the declining tenability of relying on preserving or restoring historic conditions as the primary goal of resource management, climate change obliges the cultivation of a governance system that adapts to and manages dynamic natural systems, reduces scientific uncertainty, and informs and integrates the public into an open decisionmaking process for prioritizing the resource values that matter.

I. Scientific Viability

The academic literature considering assisted migration as an adaptation strategy has focused almost exclusively on questions of scientific viability. Beyond detailing the effects of climate change on biological systems, this growing body of scholarship essentially asks whether ecologists and natural resource managers have sufficient knowledge or technical capacity to safely translocate vulnerable species to new locations with more suitable climatic conditions. Detractors assert that the administrative costs and harm associated with translocation are high; the potential for success is low; and considerable uncertainty still exists regarding the effects and scope of climate dynamics and the negative effects of introductions on receiving ecosystems. In contrast, proponents argue that the extensive ecological harms projected to occur necessitate radically new conservation methods, and that risk assessment methods can make assisted migration a viable option for helping some species adapt to climate change.

A. The Effects of Climate Change on Biological Systems

The justification for assisted migration starts with climate change—how it is fundamentally different from other environmental stressors, and how dramatic action is necessary to avert the damage it might cause to the world’s biodiversity. The projected scope, severity, and speed of climate change threaten the fundamental resilience of many ecosystems. Conventionally, every ecosystem has been subject to periodic, even substantial disturbances such as drought, flood, and fire events. Such disturbances are considered regular, even core features of resilient and dynamic ecosystems. Unfortunately, climate change threatens to move

31 See, e.g., Hoegh-Guldberg et al., supra note 3; Hunter, supra note 7; McLachlan et al., supra note 6; Ricciardi & Simberloff, supra note 7; Van der Veken et al., supra note 6; Willis et al., supra note 7.
33 See id.
ecosystems outside their historic variability at an exceptionally fast rate. As such, global climate change threatens the existence of many vital and productive ecosystems and their biological constituencies. Changes in ecological conditions due to global warming are projected to continue to affect and ultimately constrain the distribution of many species, thus increasing the risk of extinction and loss of genetic diversity. Increases in temperature over the last one hundred years (an average global rise of approximately 0.5 degrees Celsius) have already led species to shift their ranges, primarily toward the poles and higher altitudes. Many species have already experienced range contractions, and some have already gone extinct. Climate change has also led to phenological changes, such as changes in the times at which birds lay eggs and plants flower.

Yet the future effects on ecosystems due to climate change are expected to be significantly more profound. The best existing data suggests

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34 See, e.g., WORKING GROUP II, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY 8 (M.L. Parry et al. eds., 2007) ("The resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances . . . and other global change drivers."); Frank J. Rahel, Britta Bierwagen & Yoshinori Taniguchi, Managing Aquatic Species of Conservation Concern in the Face of Climate Change and Invasive Species, 22 CONSERVATION BIOLOGY 551, 557 (2008) ("Climate changes . . . may cause environmental conditions to exceed the historic range of variability to which species are adapted.").


36 The normative value of biodiversity and biological systems more broadly, which has not been directly explored in the existing literature on assisted migration, is more fully reviewed infra in Section III.A.

37 See, e.g., Osvaldo E. Sala et al., Global Biodiversity Scenarios for the Year 2100, 287 SCIENCE 1770 (2000) (predicting a decrease in global biodiversity due to changes in, and biodiversity's sensitivity to, climate, atmospheric carbon dioxide, vegetation, and land use); Chris D. Thomas et al., Extinction Risk from Climate Change, 427 NATURE 145 (2004) (predicting that 15-37% of species will be "committed to extinction" by 2050).


39 See Camille Parmesan & Gary Yohe, A Globally Coherent Fingerprint of Climate Change Impacts Across Natural Systems, 421 NATURE 37, 38 (2003) (finding that range limits of studied species moved on average 6.1 kilometers northward per decade); J. Alan Pounds & Robert Puschendorf, Ecology: Clouded Futures, 427 NATURE 107, 107 (2004) ("As warming alters [the environment], many species are shifting towards the poles or to higher elevations.").

40 Hoegh-Guldberg et al., supra note 3, at 345 ("Rapid climatic change has already caused changes to the distributions of many plants and animals, leading to several range contractions and the extinction of some species.").

41 John P. McCarty, Ecological Consequences of Recent Climate Change, 15 CONSERVATION BIOLOGY 320 (2001) [reviewing studies finding changes in flowering, spawning, breeding, and migration dates for numerous species]; Gian-Reto Walther et al., Ecological Responses to Recent Climate Change, 416 NATURE 389, 390 (2002).
that, across a wide array of future carbon emission scenarios, average global temperatures are likely to continue to rise between 2 and 11.5 degrees Fahrenheit over the next century, though increases are expected to be greater over land and closer to the poles. Changes in temperature are occurring very rapidly, requiring species to move long distances in exceptionally short periods of time to survive.

As a result, many species will need to shift their geographic distributions markedly or go extinct, as the locations they currently occupy will become unsuitable for them. The Intergovernmental Panel on Climate Change (IPCC) has projected that twenty to thirty percent of species will face an "increased" risk of extinction if average global temperature rises more than 1.5 to 2.5 degrees Celsius. A leading article in Nature concluded that by 2050 up to two-thirds of species will need to migrate or be moved to new habitats to survive. Human-induced global warming will very likely continue for at least the next twenty-five to fifty years, even in the event of immediate and significant reductions in greenhouse gas emissions. As a result, biodiversity will be threatened by climate change effects for decades.

There are a number of reasons that climate change is likely to lead to an increased risk of extinction for a variety of species. When climate changes alter the ecological conditions where a species exists, that species may be stranded or may respond in a way that is incompatible with range shifts of ecologically linked species. Some species vital to ecosystem functioning but with slow rates of dispersal—such as snails,
earthworms, and many plants—may be unable to keep up with the rate of climate change. For example, a mountaintop terrestrial species (such as the pika, a small rabbit-like mammal in the Rockies) will not be able to shift to more suitable mountaintops on its own, nor will some species on remote islands or in isolated lakes. Other stressors on wildlife or plants will be more indirect. These include increased susceptibility to predation or disease, increased competition from other species that have shifted in response to climate change, and adaptations to climate change by humans that destroy or impair existing habitat.

Perhaps the most significant impediments to range shifts are anthropogenic barriers such as cities, highways, and monoculture that inhibit migrations that might otherwise occur. Climate change will present novel challenges to species in part because any shifts in geographic distribution must be accomplished in light of existing human-induced

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50 See Daniel Simberloff et al., Movement Corridors: Conservation Bargains or Poor Investments?, 6 CONSERVATION BIOLOGY 493, 498 (1992) ("One need only consider the limited mobility of many soil invertebrates and plants to realize that a range shift would be painfully slow and require many generations."). Problems will occur for any species if migration rates are slower than changes in climate. See Ana Trakhtenbrot et al., The Importance of Long-Distance Dispersal in Biodiversity Conservation, 11 DIVERSITY & DISTRIBUTIONS 173, 174 (2005) ("[F]or species with a narrow climatic niche ... survival depends on rapid migration.").

51 Cf., e.g., Terry L. Root et al., Managing Biodiversity in the Light of Climate Change: Current Biological Effects and Future Impacts, in KEY TOPICS IN CONSERVATION BIOLOGY 85, 93 (David MacDonald & Katrina Service eds., 2007) ("As climate change causes some species to redistribute polewards and upwards, the prospects are poor for those that already inhabit high latitudes or mountains.").

52 See Ruhl, supra note 4, at 4. But see Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List the American Pika as Threatened or Endangered, 75 Fed. Reg. 6438 (Feb. 9, 2010) (declining to list the American pika as endangered or threatened under the ESA because FWS determined that sufficient high-elevation habitat exists to ensure the species' long-term survival despite higher temperatures in a majority of its range).

53 See IPCC, PHYSICAL SCIENCE, supra note 38, at 13-14.

54 See id. at 16-17.

55 See id. at 3-4, 42-43; see also Ruhl, supra note 4, at 24-26 (describing secondary ecological effects and human adaptation impacts of climate change).

56 See Malcolm L. Hunter Jr., The Biological Landscape, in CREATING A FORESTRY FOR THE 21ST CENTURY: THE SCIENCE OF ECOSYSTEM MANAGEMENT 57, 62 (Kathryn A. Kohm & Jerry F. Franklin eds., 1997) ("A highway with a high concrete curb or lane dividers can stop the movement of many less mobile animals such as turtles and amphibians. In parts of southern Africa, livestock quarantine fences have severely impeded the migration of large mammals."); Brian Lavendel, Ecological Restoration in the Face of Global Climate Change: Obstacles and Initiatives, 21 ECOLOGICAL RESTORATION 199, 202 (2003) ("Current habitat fragmentation patterns and human barriers may prevent range shifts."); see also Emma Marris, Moving on Assisted Migration, 2 NATURE REP.: CLIMATE CHANGE 112, 113 (2008) ("Humans have dominated the landscape to such an extent that natural dispersal cannot take place in many areas.... Los Angeles is a pretty big ocean for a ... butterfly to cross.").
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habitat loss, over-exploitation, invasive species, and disease. These threats have already decreased the population size and genetic vitality of many species. As a result of climate change in concert with these factors, substantial losses in species diversity will occur without active and concerted human assistance.

B. A Viable Response to Climate Change?

As a potential strategy for addressing these alarming threats to biodiversity, an increasing number of scientists and activists are claiming that assisted migration is scientifically feasible and defensible. In a prominent article in *Science* in 2008, a group of eminent scientists asserted that scientific modeling and risk assessment have improved sufficiently to make assisted migration a viable response to climate change. They claimed sufficient confidence to be able to identify situations where: (1) there is a high risk of extinction to a particular species; (2) it is technically feasible for scientists or managers to translocate and successfully establish a population of such species; and (3) there is a sufficiently low risk of adverse outcomes to the location (and the ecosystem and constituent species therein) targeted to receive the newly introduced organisms. The authors proposed a "decision framework" flow chart to determine whether assisted migration would be viable and more appropriate than conventional or passive conservation methods (such as establishing migration corridors).

Furthermore, a number of proponents point to the declared success of existing experimental efforts to translocate species outside their native range. At least one recent scientific study that experimented with the assisted migration of marbled white and small skipper butterfly populations has concluded that successful translocation is possible. However, the experiment only moved two widespread, generalist butterfly

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57 See, e.g., Christopher R. Pyke, *Habitat Loss Confounds Climate Change Impacts*, 2 FRONTIERS ECOLOGY & Env'T 178, 178 (2004) ("Humans are dramatically altering the geographic distribution of habitats . . . and the majority of terrestrial landscapes reflect a substantial degree of habitat loss and degradation. At the same time, anthropogenic forces are changing the geographic distribution of climatic conditions.").

58 See Hoegh-Guldberg et al., supra note 3, at 345.

59 Id. at 345-46.

60 Id. at 345 (encouraging conventional conservation when the risk of species decline is low, passive conservation when the risk is moderate, and translocation if the risk is high, translocation is technically feasible, and the benefits of translocation outweigh the costs). The flow chart suggests ex situ conservation or the creation of manmade habitat when existing habitat is deemed unsuitable. See id.; see also Dan McKenney, John Pedlar & Greg O'Neil, *Climate Change and Forest Seed Zones: Past Trends, Future Prospects and Challenges To Ponder*, FORESTRY CHRON., Mar./Apr. 2009, at 258, 265 (proposing assisted migration of forest tree species in Canada).
species, as opposed to specialist species that are more likely to become endangered due to climate change.\(^6\)

Similarly, activists for protecting Torreya taxifolia have made a case for the assisted migration of the conifer from Florida and Georgia to the southern Appalachians, claiming that moving the endangered plants is “[e]asy, legal, and cheap.”\(^6\)\footnote{Willis et al., supra note 7, at 45; see also Frank A. La Sorte et al., Disparities Between Observed and Predicted Impacts of Climate Change on Winter Bird Assemblages, 276 PROC. ROYAL SOC’Y B 3167, available at http://rspb.royalsocietypublishing.org/content/early/2009/06/09/rspb.2009.0162 (finding generalist species with broad ranges are likely to deal better with climate change than specialized species).} As evidence for the potential success of their project, the authors point to a group of surviving Torreya taxifolia conifers along a streamlet in the Biltmore Gardens in North Carolina, thought to have been planted there decades ago by a private party who brought the specimens from Florida.\(^6\)\footnote{Id. at 53.} Though the authors concede that the actual effects of assisted migration on the recipient environment will only become apparent once the process is carried out, they rely on the judgments of others with long associations with the plant to support the claim that it will not become noxious to its recipient ecosystem, and may even provide important shading along streams.\(^6\)\footnote{Id.} After publishing this advocacy piece, the authors created Torreya Guardians,\(^6\)\footnote{See supra notes 17-18 and accompanying text.} and they have translocated seedlings of Torreya taxifolia a number of times, claiming these translocations were a success.\(^6\)\footnote{Connie Barlow, Rewilding Torreya taxifolia to Waynesville, North Carolina, July 2008, http://www.torreyaguardians.org/waynesville-rewilding.html (last visited Apr. 8, 2010) (reporting successful relocations of thirty seedlings from a private nursery in South Carolina to two private sites in North Carolina).}

Skeptics, on the other hand, have raised a number of concerns regarding the potential costs and uncertainties of assisted migration. Many scientists have pointed out that the administrative costs of conducting an assisted migration—including planning, implementation, and long-term monitoring—are likely to be quite high.\(^6\)\footnote{See McLachlan et al., supra note 6, at 299-300.} Moreover, the risks of harm to a rare species that is translocated is itself a concern, as such a species is likely to be less able to endure the loss of even a few members to a failed introduction effort. Though an earlier study maintained that only five to twenty percent of planned introductions resulted in the successful establishment of a population of the introduced species,\(^6\)\footnote{Mark Williamson & Alastair Fitter, The Varying Success of Invaders, 77 ECOLOGY 1661, 1662 (1996) (describing the “tens rule,” which states in part that only one in ten introduced
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studies have found a success rate of about fifty percent. Studies have also found that introductions are more likely to be successful as the number of individuals introduced and the number of introduction events increase.

Many skeptics of assisted migration are more concerned about the risks of harm to the ecosystems in which species are introduced. Numerous ecologists have asserted that introductions may erode biodiversity, disrupt ecosystems, and contribute to extinctions at receiving sites. These arguments draw on the history of some intentional introductions that have led to substantial unintended harm to receiving areas when introduced species become invasive. Many introductions have caused considerable ecological and economic harm, whether intended for commercial, aesthetic, or recreational purposes. Some of the most damaging introductions actually began as attempts to ameliorate environmental problems that had grave unintended consequences to the receiving area. These include the introduction of the kudzu vine (Pueraria lobata) for erosion control in the southeastern United States, and the cane toad (Bufo marinus) to control growth of the cane beetle (Dermolepida species becomes established, though the success rate may vary by species from five to twenty percent).

69 Jonathan M. Jeschke & David L. Strayer, Invasion Success of Vertebrates in Europe and North America, 102 Proc. Nat'l Acad. Sci. 7198, 7198 (2005) ("Our results do not support the tens rule either: that ~10% of all introduced species establish themselves and that ~10% of established species spread. We find a success rate of ~50% at each step. In comparison, only 15% of native vertebrates were introduced in either direction."); M. Jake Vander Zanden, The Success of Animal Invaders, 102 Proc. Nat'l Acad. Sci. 7055, 7055-56 (2005) (discussing the results presented by Jeschke and Strayer).

70 See Jonathan M. Jeschke & David L. Strayer, Determinants of Vertebrate Invasion Success in Europe and North America, 12 Global Change Biology 1608, 1614 (2006) (finding two of the strongest predictors of invasion success to be association with humans and propagule pressure—a composite measure of the number of individuals released and number of release events—from analysis of intentional and accidental introductions of 2362 freshwater fish, mammals, and birds native to Europe and North America); Julie L. Lockwood et al., The Role of Propagule Pressure in Explaining Species Invasions, 20 Trends Ecology & Evolution 223, 223-28 (2005); see also Williamson & Fitter, supra note 68, at 1665 (finding that low success rates from introductions are typically due to low propagule pressure, the poor ability of endangered species to increase their population size, a failure of adults to reproduce at a rate sufficient to outpace the death rate, and uncertainty regarding predicting suitable habitats).


72 See id. (using introduction of the invasive purple loosestrife to illustrate introductions due to the escape of ornamental plantings).

73 See Invasive Animals Cooperative Research Centre, Rabbits, http://www.invasivenanimals.com/invasive-animals/rabbits/index.html (detailing the economic and ecological harms that resulted from introduction of rabbits into Australia).

Invasive species have played a major role in extinctions and can cause substantial changes to biotic communities. Even intra-continental translocations can cause major disruptions and extirpations. In short, introductions risk disrupting receiving biological communities, and some claim they may serve to decrease biodiversity rather than increase it.

In addition to these potential ecological harms, a related argument against assisted migration focuses on the considerable uncertainty that arises from any evaluation of its use. Some scholars forcefully dispute the existing capacity of ecologists and resource managers to evaluate, anticipate, and minimize the above-mentioned harms of implementing assisted migration. These detractors claim that existing uncertainties confound reliable risk assessment on the feasibility of assisted migration, making its current use perilous and even foolish.

Though this may be due in part to the relatively straightforward uncertainty that arises from the limited attempts to gather relevant data, perhaps more alarming is the lack of present capacity to obtain such information because of uncertainties in climate modeling. Currently, there is considerable uncertainty regarding the precise effects of future climate change on any given ecosystem or species. This is in part attributable to (1) the lack of clarity regarding what efforts humans will engage in to prevent further climatic change; (2) the global scale and complexity of climate dynamics that scientists still are trying to understand and model; and (3) the many challenges of "downscaling" these global models to ecosystem or even landscape levels. Both the limited attempts at information gathering and limited capacity of existing climate modeling result in a lack of precise, reliable scientific data relevant to any current assessment of the ecological risks of assisted migration. Such pertinent information includes (1) the localized effects of climate change on particular ecosystems or species populations; (2) the general number of species that are likely to become endangered or extinct due to climate change (let alone which specific species); (3) the number of species that are likely to become endangered or extinct if assisted migration is not attempted (and again, which specific

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75 Margarita Lampo & Giulia A. De Leo, The Invasion Ecology of the Toad Bufo marinus: From South America to Australia, 8 ECOLOGICAL APPLICATIONS 388, 388-89 (1998).
76 Ricciardi & Simberloff, supra note 7, at 248-49.
77 See id. at 249-50 (providing examples of such disturbances).
78 See id. at 250.
79 See id. at 251.
80 Alejandro E. Camacho, Adapting Governance to Climate Change: Learning To Manage Uncertainty, 59 EMORY L.J. 1, 10-13 (2009).
81 Cf. McLachlan et al., supra note 6, at 300 ("Other [non-climate] interactions, including competition, trophic associations, and mutualisms also can be important in determining the range limits of species.").
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species); and (4) the types of species that might be amenable to translocation.82

Scientists and natural resource managers also lack information important to the selection of appropriate sites for the transfer of vulnerable species.83 Scarce scientific data exists to use for modeling the climatic envelopes84 of most species,85 and existing climate envelope models are limited in accuracy and precision.86 Additionally, existing models do not predict either how the introduced species will interact with its new biotic community or how that community is otherwise being altered by climate change.87

Relatively, scientists and managers have limited capacity to forecast and thus minimize the negative effects of introductions on receiving ecosystems.88 Despite considerable scientific study, it is difficult for scientists to articulate even in hindsight why some species became invasive in particular circumstances but others did not—let alone predict which introduced species will become invasive in the future.89 Ecologists and natural resource managers cannot even rely on the frailty of endangered species in their native range to maintain that such species will be harmless when introduced elsewhere; there are numerous examples of species that are vulnerable in their native range but invasive elsewhere.90 Finally, obtaining monitoring data to better understand and adapt translocation experiments to minimize ecological and economic costs is problematic given the possibly decades-long lag between an initial introduction and a population explosion in the introduced species.91

Accordingly, any current scientific assessment of the risks of harm from a potential assisted migration confronts substantial uncertainty. Some suggest based on this uncertainty that such prospective evaluations are likely to be misleading and may underestimate the adverse effects of proposed assisted migration to the candidate species and the ecosystem in

82 See id. at 300-01.
83 Id. at 299.
84 See Chris D. Thomas et al., Extinction Risk from Climate Change, 427 NATURE 145, 145 (2004) (defining climate envelopes as "the conditions under which populations of a species currently persist in the face of competitors and natural enemies").
85 See Ricciardi & Simberloff, supra note 7, at 251 (stating that most candidate species will lack documented invasion histories because they will not have been previously introduced).
86 McLachlan et al., supra note 6, at 300.
87 See id. at 300-01 (explaining that there is a lack of understanding about community interactions when a range shift is driven primarily by climate change, similar to the "limited success in identifying likely invasive species").
88 See Ricciardi & Simberloff, supra note 7, at 251.
89 Id.
90 Id. ("[T]he biological traits that promote endangerment are not simply the opposite of those that favor invasiveness.").
91 Id.; see also McLachlan et al., supra note 6, at 299.
which it is proposed to be introduced. These critics claim that such uncertainties should lead to the rejection of assisted migration as a climate change adaptation strategy. On the other hand, other scientists state that these uncertainties can be reduced and managed. Perhaps more importantly, these scholars insist that the inevitably widespread and extensive harm to biological systems from climate change necessitates consideration of this admittedly extreme strategy.

II. Legal Feasibility

In addition to questions of scientific feasibility, the question whether assisted migration can be a viable strategy for helping biota adapt to climate change turns on whether it is legal. Though its viability as a climate change adaptation measure remains contested, assisted migration appears to be legally permissible in narrow but clear circumstances. On the other hand, as detailed infra in Section II.B, prevailing natural resource law directives that seek to promote native ecosystems, limit non-native species, and fragment natural resource management do not provide a framework that supports assisted migration as a prevalent management strategy. Though translocations of non-native species may be tolerated in rare cases, it is evident that the law does not contemplate the extensive use of such a broad strategy for managing climate change or other widespread environmental stressors.

A. Existing Options for Non-Native Translocation

The legality of assisted migration in any instance is a function of a variety of factors that reflect the incredibly fragmented character of natural resource management. These factors include: (1) the type of species that is being moved (including whether it is flora or fauna, and whether it is listed as either an invasive or a rare species under state or federal law); (2) the type of party undertaking the assisted migration (including whether it is a private party or a state, local, tribal, or federal natural resource agency); and (3) the type of site (for example, private property, state property, tribal property, municipal property, or one of various federal lands) where candidate organisms are currently located and where they are proposed to be moved. Each of the possible permutations is governed by an array of

92 See Ricciardi & Simberloff, supra note 7, at 251.
93 Id. at 252.
94 Hoegh-Guldberg et al., supra note 3, at 345-46.
95 Id.
96 See Richardson et al., supra note 5, at 9722.
97 These federal lands include, among others, national parks, national forests, Bureau of Land Management (BLM) land, and designated wilderness areas.
local, state, federal, and international natural resource management laws, including diverse laws pertaining to endangered species, public land management, and invasive species.

Though detailing the legality of each variation is beyond the scope of this Article, a few categories are worth exploring. For private individuals, engaging in assisted migration can be relatively easy under existing law. Many species are not listed as endangered or invasive under federal or state law, and thus their private transport is minimally regulated. Depending on the circumstances, even private movement of listed endangered species can be straightforward.

For example, Torreya Guardians' numerous assisted migration operations do not appear to expressly violate existing natural resource management laws. Torreya taxifolia is listed as an endangered plant under the ESA.\(^8\) The ESA includes a very broad prohibition on the "take" (including harm) of any listed endangered fish or wildlife species.\(^9\) For endangered plants, however, the ESA only makes it unlawful to import, export, remove from federal land, sell or offer for sale in interstate commerce, or "deliver, receive, carry, transport, or ship in interstate or foreign commerce, by any means whatsoever and in the course of a commercial activity, any such species."\(^10\) Torreya Guardians apparently obtained seedlings from a private nursery and then transplanted them onto private property.\(^11\) Even if they transported the plants across state lines, they could argue they did not do so "in the course of a commercial activity" but rather for conservation purposes, though the scope of this provision is not unambiguous. As they did not otherwise import, export, or remove listed plants from federal land, or violate any other federal or state regulations,\(^12\) their activities presumably were legal. Paradoxically, as detailed in the following subsections, under existing law it may often be more difficult for federal agencies to engage in assisted migration than it is for private parties.

\(^8\) 50 C.F.R. § 17.12(h) (2008).
\(^9\) 16 U.S.C. § 1538(a)(1) (2006) ("[W]ith respect to any endangered species of fish or wildlife listed . . . it is unlawful . . . to . . . (B) take any such species within the United States or the territorial sea of the United States."); id. § 1532(19) ("The term 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."); see also Babbitt v. Sweet Home Chapter of Cmty. for a Great Or., 515 U.S. 687 (1995) (determining that FWS's interpretation of the statutory definition of "harm" to include "significant habitat modification or degradation" that significantly impairs breeding, feeding, or sheltering patterns was reasonable).
\(^11\) See Barlow & Martin, supra note 1, at 52, 53.
\(^12\) For example, Torreya taxifolia is not listed as invasive or as a noxious weed under North Carolina or federal law. E.g., 2 N.C. ADMIN. CODE 48A.1703, .1705, .1706 (2009).
1. For Federally Listed Endangered Species

As the anticipated effects of climate change on rare species are a key motivation for assisted migration, species listed under the ESA are the most obvious to consider for this strategy. The federal ESA might allow private or public parties to translocate a listed species either as an experimental population under section 10(j) or for other general scientific purposes through section 10(a)(1)(A). The latter section allows the FWS or National Marine Fisheries Service (NMFS) (collectively, the “Services”) to grant permits to take and move a member of a species "for scientific purposes or to enhance the propagation or survival of the affected species, including, but not limited to, acts necessary for the establishment and maintenance of experimental populations.”

ESA section 10(j) further details the requirements for experimental populations, stating that the Services may authorize the transport and release of any populations as experimental if the release (1) is outside the species’ current range; (2) is kept wholly separate geographically from other populations of the species; and (3) “will further the conservation of such species.” Under the FWS’s current interpretation of section 10(j), the FWS may even authorize the release of an experimental population outside the species’ “probable historic range... in the extreme case that the primary habitat of the species has been unsuitably and irreversibly altered or destroyed.” Once an experimental population has been introduced, the ESA provides less protection for such a population than would otherwise exist for a listed species.

Alternatively, the Services may just rely on section 10(a)(1)(A). This provision allows the Services to provide permits authorizing the taking and movement of a member of a listed species “for scientific purposes or to

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104 id. § 1539(a)(1)(A). In addition, any proposed translocation of a listed or non-listed species authorized, funded, or carried out by a federal agency would need to comply with ESA section 7, which requires federal agencies to consult with the FWS and National Marine Fisheries Service (NMFS) and ensure that any proposed action does not jeopardize any listed species or destroy or adversely modify critical habitat. See id. § 1536(a)(2).
105 The ESA is administered by the FWS for land and freshwater species, while the NMFS has jurisdiction over marine species. See id. § 1532(15); id. § 1533(a)(2); 50 C.F.R. § 424.01 (2007) (FWS/NMFS joint regulations).
107 Id. § 1539(j)(1). (2).
108 50 C.F.R. § 17.81(a) (2009). Though the FWS made this finding for the Guam rail (Gallirallus owstoni), a bird native to Guam, the FWS nonetheless has been able to return the Guam rail to Guam. See M. Kelly Brock & Grant M. Beauprez, The Rail Road to Recovery, ENDANGERED SPECIES BULL., Jan.-Apr. 2000, at 6, available at http://www.fws.gov/endangered/bulletin/2000/01-04/06-07.pdf.
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enhance the propagation or survival of the affected species."\textsuperscript{110} Significantly, the FWS regulation restricting introduction of an experimental population of a species to the species' historic range except in extreme cases would not apply. However, unlike for populations moved pursuant to section 10(j), subsequent activities affecting populations moved pursuant to section 10(a)(1)(A) would still be subject to all general restrictions on the take or movement of listed species under the ESA.\textsuperscript{111}

2. By Federal Land Management Agencies

Each of the major federal resource land agencies—the FWS, United States Forest Service (USFS), Bureau of Land Management (BLM), and National Park Service (NPS)—is subject to a different statutory scheme, and each of these agencies has promulgated regulations and other guidance documents further interpreting its statutory authority. Though there is considerable variability between these federal agencies in their capacity to engage in assisted migration, these agencies have each interpreted their authority in a way that currently allows assisted migration in at least some circumstances. However, there are some federal lands, particularly the one hundred million acres of designated wilderness areas, for which assisted migration is unlikely to be permissible.

In addition, even if a federal agency were allowed under its governing public land law to engage in assisted migration, the agency would still need to comply with existing restrictions on the introduction by federal agencies of any invasive species. Under Executive Order 13,112, "invasive species" is defined as "an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health."\textsuperscript{112} Prior to any introduction by a federal agency, the agency must determine if the introduced species is invasive, and if so it cannot introduce the species unless "the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions."\textsuperscript{113}

\begin{footnotes}
\item[110] Id. § 1539(a)(1)(A); see also 50 C.F.R. §§ 17.22(a), 17.32(a), 17.62 (2009) (discussing further the process for FWS permits provided under ESA section 10(a)(1)(A)).
\item[111] See supra note 99 and accompanying text.
\item[113] See id. at 6184. In addition, there is a thicket of other federal invasive species laws that regulate the movement of animals and plants. However, these laws are likely to play only a small role in proposed assisted migrations in the rare circumstance when the species has already been listed as invasive, noxious, or a pest. See, e.g., Plant Protection Act, 7 U.S.C. §§ 7701-7786 (2006); Lacey Act, 18 U.S.C. § 42 (2006); Alien Species Prevention and Enforcement Act, 39 U.S.C. § 3015 (2006).
\end{footnotes}
a. National Forests

USFS appears to have sufficient flexibility to engage in assisted migration for designated desired species if introduction conforms with multiple-use objectives and federal invasive species restrictions. The National Forest Management Act (NFMA), the primary management statute for the USFS, requires the periodic adoption of detailed management plans for each national forest, but provides the USFS significant discretion in such planning and management activities. The NFMA affirms that the national forests are multiple-use lands, meaning the USFS must manage the lands to give due consideration to various uses, such as “outdoor recreation (including wilderness), range, timber, watershed, wildlife, and fish.” However, the USFS has considerable discretion to determine the appropriate balance of these uses. The primary requirement for protecting biodiversity in the NFMA states that NFMA plans must “provide for diversity of plant and animal communities… in order to meet overall multiple-use objectives.” The USFS has interpreted this “diversity” provision to require plans to “maintain viable populations of existing native and desired non-native vertebrate species in the planning area.” Such an interpretation displays the USFS’s longstanding historical acceptance of certain “desired” non-native species in national forests.

115 The Forest Service Organic Administration Act of 1897, 16 U.S.C. § 475 (2006), created the USFS, and the Multiple-Use Sustained-Yield Act of 1960, id. §§ 528-531, broadened the use objectives of the national forests to include “outdoor recreation, range, timber, watershed, and wildlife and fish purposes.” Id. § 528.
116 See GEORGE C. COGGINS & ROBERT L. GLICKSMAN, PUBLIC NATURAL RESOURCES LAW § 32.27 (2009).
118 See JAN G. LAITOS, NATURAL RESOURCES LAW 163 (2002).
119 16 U.S.C. § 1604(g)(3)(B) (2006). It also requires “to the degree practicable, for steps to be taken to preserve the diversity of tree species similar to that existing in the region controlled by the plan.” Id. § 508.
121 See Joly & Fuller, supra note 2, at 10,419 (describing the acceptance of non-native species such as cattle, sheep, fish, and other wildlife on USFS lands). A recent attempt to amend this regulation removed any explicit reference to maintaining non-native species. See 36 C.F.R. § 219.10(b) (2009) (“The overall goal of the ecological element of sustainability is to provide a framework to contribute to sustaining native ecological systems by providing appropriate ecological conditions to support diversity of native plant and animal species in the plan area.”). However, a federal district court rejected these proposed revisions. See Citizens for Better Forestry v. U.S. Dept of Agric., No. C-08-1927-CW, 2009 WL 1883728 (N.D. Cal. June 30, 2009) (determining that the 2008 rule violated the National Environmental Policy Act and the ESA). In response, the USFS reinstated the 2000 rule, as amended in 2001 and 2003, for use until a new rule can be promulgated. See National Forest System Land and Resource Management Planning. 74 Fed. Reg. 67,059 (Dec. 18, 2009) (to be codified at 36 C.F.R. pt. 219). Because the USFS deemed the 2000 NFMA rule unworkable, see id. at 67,059-60, it gave notice of its intent to prepare an
In addition, there are USFS Manual provisions that specifically allow for the introduction of non-native species into national forests. A recently adopted provision allows for non-native plants to be used in revegetation or restoration efforts, though they expressly prioritize native species first. Another section states:

It is Forest Service policy to: (1) . . . [A]ssist in stocking and introduction operations . . . to recover threatened and endangered species, and to introduce new species . . . . (3) . . . Introduc[e] or stock[] . . . species [so as] to introduce new species desired by the public. (4) Favor native or desirable non-native species over new exotic species in stocking and introductions.

This provision is not likely to be binding on the agency, and new non-native species may be lower in the pecking order than native species. Nonetheless, proponents of assisted migration could argue that these provisions serve as persuasive guidance for allowing the introduction of non-native species into national forests. Thus, existing USFS regulations may allow assisted migration if USFS (1) has designated the species as a desired species; (2) determines introduction meets multiple-use objectives; and (3) finds (in conformance with federal invasive species restrictions) that the benefits of the species’ introduction (based on existing information) clearly outweigh the potential harm.

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environmental impact study to analyze the impact of changing the existing rule. See National Forest System Land Management Planning, 74 Fed. Reg. 67,165 (Dec. 18, 2009). In that notice, the USFS solicited input for “new ways to meet [the] diversity requirements [of the NFMA].” Id. at 67,168. Though the notice makes no mention of whether maintaining viable populations of desired non-native species will be required or permitted, the USFS anticipates that the new rule will attempt to “provide for diversity in a way that achieves protection for species, habitats, and ecosystems while taking into account environmental and management factors and impacts that are outside of the Agency’s control.” Id.

122 U.S. FOREST SERV., U.S. FOREST SERVICE MANUAL § 2070.3 (2008), available at http://www.fs.fed.us/im/directives/dughtml/fsm.html [hereinafter USFS MANUAL] (stating that non-native plants are only allowed if they are (1) “interim, non-persistent plant materials” and “designed to aid in the re-establishment of native plant communities” or (2) “persistent, non-native, non-invasive plant materials . . . when timely reestablishment of a native plant community either through natural regeneration or with the use of native plant materials is not likely to occur”).

123 Id. § 2640.3; see also id. § 2642 (“Occasionally, areas and conditions are found that would best suit fish or wildlife that are not indigenous to a forest. Introductions of wild turkeys in certain western forests are an example.”).

b. BLM Lands

BLM's statutory authority provides the agency even greater discretion than the USFS has to introduce non-native species. Like national forests, lands governed by the BLM are subject to a multiple-use mandate under the Federal Land Policy and Management Act of 1976 (FLPMA).\(^{125}\) FLPMA mandates BLM planning but provides the BLM extensive substantive discretion. The only definitive standards for BLM planning require the designation and protection of areas of critical environmental concern and compliance with pollution control laws.\(^{126}\) The BLM is also not subject to any requirement akin to the NFMA's diversity requirement.

The BLM has historically allowed the introduction of non-native species onto BLM lands, most noticeably cattle and sheep for grazing.\(^{127}\) BLM regulations address non-native introductions in the context of grazing management, where planting of non-native plant species is accepted only if native vegetation is unavailable or inadequate.\(^{128}\) The BLM Manual—which is likely non-binding but nonetheless provides some guidance regarding the BLM's interpretations of its own authority\(^{129}\)—further explains:

Native species shall be used, unless... it is determined that: (1) Suitable native species are not available; (2) The natural biological diversity of the proposed management area will not be diminished; (3) Exotic and naturalized species can be confined within the proposed management area; (4) Analysis of ecological site inventory information indicates that a site will not support reestablishment of a species that historically was part of the natural environment; (5) Resource management objectives cannot be met with native species.\(^{130}\)

In addition, the BLM Manual states that “[s]pecial exemptions to allow transplanting outside of a species’ historical range may be provided for those [threatened or endangered] species for which remaining historical habitat has been destroyed or otherwise rendered unsuitable.”\(^{131}\)

\(^{125}\) 43 U.S.C. §§ 1701-1785 (2006). For more on the multiple-use mandate, see 43 U.S.C. § 1732(a), which discusses the mandate’s applicability, and 43 U.S.C. § 1702(c), which defines multiple-use management as “management of the public lands and their various resource values so that they are utilized in the combination that will best meet the present and future needs of the American people.”


\(^{127}\) See id. § 1702(c).


\(^{130}\) U.S. BUREAU OF LAND MGMT., BUREAU OF LAND MANAGEMENT MANUAL § 1745.06(A) (1992) [hereinafter BLM MANUAL].

\(^{131}\) Id. § 1745.3.
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On the other hand, the BLM Manual also states that for species listed under the ESA, "[t]he release of federally-listed species designated as experimental populations shall be restricted to habitat documented as 'historic range' and outside the current geographic range for the identified species." Furthermore, the BLM Manual includes as a core objective ensuring that "the introduction of exotic species is ecologically sound and will not adversely impact natural ecosystems and their biological diversity." As with all federal agencies, BLM introductions must also comply with restrictions on invasive species introductions.

c. Federal Wildlife Refuges

In its function as manager of the National Wildlife Refuge System, the FWS leaves open the possibility of introducing non-native species if the species is listed under the ESA and doing so is essential for species survival. In addition to administering the ESA, the FWS manages the National Wildlife Refuge System pursuant to the National Wildlife Refuge System Improvement Act (NWRSIA). The mission of this system is to serve as "a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States." The NWRSIA delegates to the FWS the power to engage in a variety of measures to conserve fish, wildlife, plants, and their habitats, including "propagation, live trapping and transplantation." However, it does not directly address whether non-native introductions are allowed. The statute does grant the Secretary of the Interior emergency power to "temporarily suspend, allow, or initiate any activity in a refuge in the System if the Secretary determines it is necessary to protect the health and safety of the public or any fish or wildlife population." The only reported case that addresses the potential scope of this emergency power provides little direction on the duration of this temporary authority.

132 Id. § 1745.31.
133 Id. § 1745.02(2); see also id. § 1745.02(1) (stating that BLM must "[e]nsure that management of native, naturalized and exotic species enhances, restores, and does not reduce the biological and genetic diversity of natural ecosystems and provides for the protection of soil resources").
134 See supra notes 112-113 and accompanying text.
136 Id. § 668dd(a)(2).
137 Id. § 668ee(4).
138 Id. § 668dd(k).
139 Wyoming v. United States, 279 F.3d 1214, 1240 (10th Cir. 2002) (indicating only that because the program at issue was commenced "over a decade ago... the 'temporary' nature of FWS's action has long since passed").
The FWS's Manual\textsuperscript{140} and Refuge System Manual,\textsuperscript{141} however, specifically address non-native introductions.\textsuperscript{142} The FWS Manual states: "We do not introduce species on refuges outside their historic range... unless such introduction is essential for the survival of a species and prescribed in an endangered species recovery plan, or is essential for the control of an invasive species and prescribed in an integrated pest management plan."\textsuperscript{143} Additionally, the FWS Refuge System Manual appears to provide a process for proposing the introduction of exotic species, limiting such introductions to bar reintroduction of naturally extirpated exotics, exotic birds, or species anticipated to be invasive or to cause detrimental effects on the receiving area.\textsuperscript{144} Accordingly, there is at least some authority and precedent, though limited, for the FWS to engage in assisted migration on Federal Wildlife Refuges.

d. National Parks

Existing interpretations by the NPS of its authority likely provide the agency the ability to translocate closely related native species but not entirely new exotic species. The NPS manages the national parks under the National Park Service Organic Act's core preservation mandate: "to conserve the scenery and the natural and historic objects and the wild life therein... as will leave them unimpaired for the enjoyment of future generations."\textsuperscript{145} If an action could lead to the impairment of park resources or values, it cannot be approved.\textsuperscript{146} There is a presumption of protecting existing natural resources from human activity or management,\textsuperscript{147} as well as a preference for natural processes and native species.\textsuperscript{148} Thus, though

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141 U.S. FISH & WILDLIFE SERV., NATIONAL WILDLIFE REFUGE SYSTEM MANUAL (2008) [hereinafter FWS REFUGE SYSTEM MANUAL].
143 FWS MANUAL, supra note 140, pt. 601, § 3.14(F); see also id. pt. 601, § 3.11(C) (stating that for non-native introductions the FWS strives "to minimize unnatural effects and to restore or maintain natural processes and ecosystem components to the extent practicable without jeopardizing refuge purpose(s)").
144 See FWS REFUGE SYSTEM MANUAL, supra note 141, §§ 7-8.6(B), 8.7.
147 See id. ("In cases of uncertainty as to the impacts of activities on park natural resources, the protection of natural resources will predominate.").
148 id. § 4.4.2 ("Whenever possible, natural processes will be relied upon to maintain native plant and animal species and influence natural fluctuations in populations of these species.").
\end{flushleft}
the NPS has broad discretion in interpreting its statutory authority; the NPS generally must take a preservationist approach to existing natural resources.

Though the NPS's operative statutory authority does not discuss the permissibility of species introductions in national parks, the NPS's Management Policies do. These Management Policies serve as guidance for NPS officials in implementing the Organic Act and provide the NPS at least the discretion (and potentially the obligation) to reintroduce extirpated populations of vulnerable native species. In addition, as part of the NPS's obligation to strive to protect the full range of genetic types of native populations in parks, the Management Policies allow for the transplantation of organisms to maintain appropriate levels of genetic diversity.

However, these policies make translocations for non-native species far more difficult. In general, the NPS prohibits the introduction of non-native species and seeks to remove any non-native species in national parks. Yet, the NPS Management Policies state:

In rare situations, an exotic species may be introduced or maintained to meet specific, identified management needs when all feasible and prudent measures to minimize the risk of harm have been taken and it is a closely related race, subspecies, or hybrid of an extirpated native species; or an improved variety of a native species in situations in which the natural variety cannot survive current, human-altered environmental conditions.

Accordingly, the NPS Management Policies would only allow the NPS to engage in assisted migration in very narrow situations involving species closely related to native species and when the effect of the introduction on the native ecosystem is minimized.

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149 See Davis v. Latschar, 202 F.3d 359, 365 (D.C. Cir. 2000).
151 See NPS MANAGEMENT POLICIES, supra note 146, § 4.4.2.3 (“The Service will... protect, and strive to recover all species native to national park system units that are listed under the Endangered Species Act. The Service will... undertake active management programs to... reestablish extirpated populations as necessary to maintain the species and the habitats upon which they depend.... In addition, the Service will inventory other native species that are of special management concern to parks... and will manage them to maintain their natural distribution and abundance.” (emphasis added)).
152 See id. § 4.4.1.2 (“The restoration of native plants and animals will be accomplished using organisms taken from populations as closely related genetically and ecologically as possible to park populations, preferably from similar habitats in adjacent or local areas. Deviations... may be made where the management goal is to increase the variability of the park gene pool to mitigate past, human-induced loss of genetic variability.”).
153 Id. § 4.4.4.1.
154 Id.
e. Wilderness Areas

Because areas designated as wilderness pursuant to the Wilderness Act of 1964 must be protected to preserve their natural conditions and wild character, they are the least likely of federal lands to be accepted venues for assisted migration. The best argument in favor of allowing assisted migration in wilderness areas is that there is no legal authority directly on point prohibiting its use. The Wilderness Act focuses on protecting designated wilderness, defined in large part as follows:

[Wilderness is] an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. [It is] an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which . . . generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable.

Wilderness is a special designation that Congress overlays on parts of already existing federal lands; thus, the federal agency that manages the land before such designation is charged with administering the area specifically as wilderness. Federal agencies must ensure that wilderness areas "shall be administered . . . in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas [and] the preservation of their wilderness character." A wilderness area must be "protected and managed so as to preserve its natural conditions."

However, though some level of temporary, secondary, and insubstantial human interference is implicitly contemplated, neither the statute nor case law provides clear guidance on how much human interference or active management is permissible or required in wilderness areas. The statute could be construed to prohibit substantial

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156 Id. § 1131(c).
159 See id. § 1131(c).
160 See id. (excluding only "permanent improvements or human habitation" and ensuring an area "generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable" (emphasis added)).
161 In one of the few reported cases considering if active management of wilderness areas was permissible, the Ninth Circuit considered whether a fishery enhancement project, "an activity with a benign aim to enhance the catch of fishermen, with little visible detriment to
active management; alternatively, it could be understood to require active management to ensure outside human activities do not interfere with statutory goals—preserving wilderness character and natural conditions. No case has directly addressed the specific question of whether or not the introduction of non-native species is legal. Yet even if the Wilderness Act were interpreted to allow active management, such management would nonetheless have to be in furtherance of the Act’s purposes. Any agency wishing to engage in assisted migration in a wilderness area thus would have to make the improbable determination that introducing a new non-native species is consistent with preserving wilderness character and natural conditions.

3. Under State Laws

Though a comprehensive exposition of state natural resource laws is outside the scope of this Article, even a brief survey demonstrates that many state regimes are sufficiently flexible to allow assisted migration under certain circumstances. To date, no state has developed a statutory regime specifically designed to regulate assisted migration. However, there are many state laws pertaining to endangered species, invasive species, and general wildlife management, and unsurprisingly these state regimes vary considerably.

wilderness,” was allowed in a wilderness area. See Wilderness Soc’y v. U.S. Fish & Wildlife Serv., 353 F.3d 1051, 1062 (9th Cir. 2003) (en banc). In the initial panel decision, the Ninth Circuit did consider the permissible level of human interference in wilderness areas. See Wilderness Soc’y v. U.S. Fish & Wildlife Serv., 316 F.3d 913, 924 (9th Cir. 2003) (determining that “[w]hile the wilderness must be ‘protected’ so that its natural processes dominate, it also must be ‘managed’ so that human activities from outside the area do not interfere unduly”). However, in the subsequent en banc decision, the court bypassed this issue, focused primarily on the Wilderness Act’s prohibition on commercial enterprises, and determined that the project violated this provision because it was commercial in nature. Wilderness Soc’y, 353 F.3d at 1067.

In another series of cases, the District Court for the District of Columbia eventually upheld active management of a wilderness area. See Sierra Club v. Lyng, 663 F. Supp. 556 (D.D.C. 1987); Sierra Club v. Block, 614 F. Supp. 488 (D.D.C. 1985). In these cases, the USFS sought to implement a plan controlling the invasive southern pine beetle. See Block, 614 F. Supp. at 490. The plan involved extensive felling of infected trees located in wilderness areas, partly out of concern that the infestation would spread to adjacent commercially-harvested properties. Id. The court initially granted a preliminary injunction, citing National Environment Policy Act violations. See id. at 494. However, the court excluded from the injunction the felling of trees where necessary to ensure the survival of the red-cockaded woodpecker, an endangered species. See id. In a later case dealing with the same project, the court approved the USFS’s plan, concluding that the plan was “necessary” to preserve the wilderness character of the area, and thus was consistent with the Wilderness Act. See Lyng, 663 F. Supp. at 560-61.

162 See Wilderness Soc’y, 316 F.3d at 923-24 (discussing these alternative interpretations); Daniel Rohlf & Douglas L. Honnold, Managing the Balances of Nature: The Legal Framework of Wilderness Management, 15 ECOLOGY L.Q. 249, 259 (1988) (“Significantly, Congress phrased this preservation mandate affirmatively, suggesting that wilderness managers may be obligated to take affirmative actions to preserve or even restore wilderness character.”).
The vast majority of state endangered species statutes follow the general template of the federal ESA, with a prohibition on taking an endangered species without a permit, though there are differences in the specific activities prohibited and permitted. Three of these statutes specifically provide for the introduction or reintroduction of non-native listed species, while Maine allows for introduction and reintroduction, suggesting that introduction may include non-native species. In addition, Hawaii’s endangered species statute expressly allows the release of listed species outside their native range, Oregon regulations allow state agencies or private parties to transplant non-native vulnerable species to “a site deemed environmentally appropriate,” and Pennsylvania allows permits for the import or export of non-native listed animals if accompanied by a federal permit. Furthermore, most states allow permits for scientific purposes, while others specifically allow permits to enhance the propagation or survival of the species. Though such provisions do not expressly authorize introduction outside a species’ historic range, they might be interpreted as allowing assisted migration activities.

Similarly, though the permit requirements and species classifications in state wildlife management laws vary, most of these laws provide latitude for the movement of wildlife and vegetation. Almost all states prohibit
importation of certain flora or fauna into the state without a permit, and some extend this permit requirement to releases within the state. To effectuate these restrictions, most states have either promulgated blacklists of invasive, noxious, or pest species that may not be imported into the state, or placed species in categories with varying degrees of restrictions (such as unregulated, regulated, restricted, or prohibited). Generally, if an organism is not on the blacklist or otherwise restricted, no permit is required. Many states include a number of exceptions to a blacklist or tiered classification, such as for activities undertaken for “scientific” or “experimental” purposes.

Perhaps some candidates for assisted migration will be restricted or blacklisted in a potential receiving site. However, the species most vulnerable to the effects of climate change will tend to be endangered or relatively rare, and thus few of them will be listed as invasive, otherwise blacklisted, or heavily restricted under state wildlife management laws. In addition, as for federal land agencies, some states provide exceptions to permit requirements for activities by state agencies, and may even specifically allow introductions of new species. Accordingly, though the permissibility of introducing any particular organism to a specific site outside its historic range depends on a multiplicity of factors, most states appear to leave the door open for assisted migration.

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170 See, e.g., ALASKA STAT. § 16.05.921 (2010); ARIZ. REV. STAT. ANN. § 17-306 (2010); IOWA CODE ANN. § 481A.47 (West 2009). States that do not appear to have this permit requirement include Colorado, Louisiana, Missouri, and North Dakota.

171 See, e.g., ARIZ. REV. STAT. ANN. § 17-306 (2010) (requiring state game and fish commission approval to import, transport, sell, possess, trade, or release wildlife); CAL. FISH & GAME CODE § 3515 (West 2010) (“Exotic nonresident game birds may be released in this State only on prior approval of the commission.”); N.C. GEN. STAT. § 113-292 (2009) (requiring a permit from a commission to release non-indigenous wild animals or birds to stock an area for hunting).


173 See, e.g., MINN. STAT. ANN. § 84D.04 (West 2010); MISS. CODE ANN. § 49-1-29 (2010). A few states are more restrictive, with “whitelists” of types of species which may be imported or released, explicitly or implicitly prohibiting importation and release of all others. Illinois, for example, maintains whitelists of birds and of aquatic species that may be imported and released without a permit. See ILL. ADMIN. CODE tit. 17, § 870.10(a), (b) (2010).

174 See, e.g., ARIZ. ADMIN. CODE § 12-4-405 (2008) (allowing importation of lawfully possessed non-restricted mammals, birds, and reptiles without a permit).

175 See, e.g., KAN. ADMIN. REGS. § 115-18-10 (2010) (providing an exception for experimental and scientific purposes); 301 KY. ADMIN. REGS. 2:082(2)(2) (2010) (granting an exception for scientific or research permits).

176 A few states grant agencies authority to propagate species necessary for stocking programs. See, e.g., CAL. FISH & GAME CODE § 1007 (West 2009); IDAHO ADMIN. CODE r. 13.01.03.100(01)(j) (2010).

177 See, e.g., ALASKA STAT. § 16.25.010 (2008) (authorizing a program of stocking valuable game and fur-bearing animals not present on the receiving land).
B. A Dissonance with Natural Resource Law

However, the regular use of assisted migration appears to be incongruent with the regulatory structure and core goals of conventional natural resource law in the United States. The intentional introduction of a species outside its historic range would subvert a dominant objective of existing natural resource law—preserving native ecosystems. In addition, the fragmented system of American natural resource governance was not designed to facilitate large-scale movements and long-term management of non-native species. As a result, existing law is poorly equipped to provide for regular reliance on assisted migration as a strategy for helping natural resources adapt to the effects of climate change.

1. Inconsistent with Resource Preservation Mandates

The same natural resource laws that allow translocations in certain narrow circumstances also repeatedly seek to discourage the introduction of non-native species and otherwise suggest that the use of assisted migration would frustrate core natural resource management objectives. Though the FWS does contemplate the introduction of federally listed endangered species outside their native range, it also expressly considers such a strategy to be an "extreme case." In fact, when adopting this regulation, the FWS rejected suggestions to allow widespread introductions outside a species' native range:

Long-standing Service policy provides that the relocation or transplantation of native listed species outside their historic range will not be authorized as a conservation measure. ... [I]t is Service policy to restrict introductions of listed species to historic range, absent a finding by the Director in the extreme case that the primary habitat of the species has been unsuitably and irreversibly altered or destroyed. The Service believes this is the most biologically acceptable approach to utilize in species introductions. Further, the purposes and policies of the Act would be violated if the Service were to regularly permit the introduction of listed species into new habitat areas as exotic species. Under [the ESA], the Service must commit itself to ecosystem protection . . . Generally, the transplantation of listed species to non-native habitat abandons the statutory directive to conserve species in native ecosystems. Transplantation of listed species beyond historic range would subject the population to doubtful survival chances and might result in the alteration of the species' gene pool—results that are clearly contrary to the goals of the Act.179

178 50 C.F.R. § 17.81(a) (2009).
179 Id. § 17.81.
The FWS also argued that “releasing any species into non-native habitat runs afoul of the spirit of Executive Order 11,987, which prohibits the introduction of exotic, foreign species into the natural ecosystems of the United States."\textsuperscript{180} Thus, though allowing for the use of assisted migration in rare circumstances, the FWS nonetheless suggests that its regular use for endangered species would violate the ESA and other federal mandates.

This aversion to non-native introduction is borne out by the practice of the FWS in authorizing translocations under the ESA. Since the creation of section 10(j),\textsuperscript{181} the FWS has translocated or permitted the translocation of thirty-six endangered species pursuant to that provision. However, only two of these were moved outside their probable historic range.\textsuperscript{182} FWS temporarily moved a population of red wolves (\textit{Canis rufus}) to a National Wildlife Refuge on coastal islands off of Florida, North Carolina, and South Carolina on which there are no records of wolf settlement.\textsuperscript{183} The FWS did this as an interim method for allowing wolves to adapt in isolated conditions;\textsuperscript{184} after a short period, the wolves were relocated to National Wildlife Refuge and national park lands in the species' historic range.\textsuperscript{185} Likewise, in 1989 the FWS introduced the Guam rail (\textit{Gallirallus owstoni}), a bird native to Guam, to the island of Rota (approximately sixty kilometers northeast of Guam).\textsuperscript{186} The FWS found that brown tree snakes had decimated the rail's native habitat in Guam, and that "captive-held rails are known to become tame over time and lose their ability to survive in the wild."\textsuperscript{187} Accordingly, the FWS translocated rails to a location with similar habitat but no snakes, and outside the rail's historic range.\textsuperscript{188} However, the FWS has stated that its plan is to eventually reintroduce the rail back to

\begin{footnotes}
\item[180] \textit{Id.}
\item[181] Before Congress created section 10(j) in 1982, endangered snail darters (\textit{Percina tanasi}) had also been moved out of their known range. See Patrick D. Shirey & Gary A. Lamberti, \textit{Assisted Colonization Under the U.S. Endangered Species Act}, 3 CONSERVATION LETTERS 45, 49 (2010).
\item[182] Andrew Thompson, Case Studies Related to AM: Examples of Federally Listed Animal Species That Have Been Translocated over the Past 30 Years (Dec. 31, 2008) (unpublished manuscript, on file with the Yale Journal on Regulation).
\item[183] \textit{U.S. FISH \\& WILDLIFE SERV. \\& U.S. DEPT. OF INTERIOR, RED WOLF RECOVERY/SPECIES SURVIVAL PLAN} 17-20 (1990), \textit{available at} \url{http://ecos.fws.gov/docs/recovery_plan/901026.pdf} [hereinafter \textit{RED WOLF RECOVERY/SPECIES SURVIVAL PLAN}]. These islands are, however, within the wolf's historic range, which extends throughout the southeastern United States. See Joly & Fuller, \textit{supra} note 2, at 10,416-17.
\item[184] See Joly & Fuller, \textit{supra} note 2, at 10,417.
\item[185] \textit{RED WOLF RECOVERY/SPECIES SURVIVAL PLAN, supra} note 183, at 17-20.
\item[187] \textit{Id.} at 43,966.
\item[188] \textit{Id.} at 43,967.
\end{footnotes}
Guam when conditions become favorable.\textsuperscript{189} Thus, even the two circumstances involving non-native endangered species introductions under section 10(j) by the FWS have extenuating circumstances.\textsuperscript{190}

Similarly, there has been at least one instance under a section 10(a)(1)(A) permit in which a listed desert pupfish population was established forty-four kilometers northwest of its historic range.\textsuperscript{191} However, unlike for populations moved pursuant to section 10(j), any population introduced under section 10(a)(1)(A) would be protected by the ESA's generally applicable strict protections against take.\textsuperscript{192} As a result, the FWS has only relied on this provision for proposed introductions in the rare circumstance when there has been little controversy.\textsuperscript{193} Accordingly, even the few cases in which species were introduced into new areas show the reluctance of the FWS toward moving even endangered species outside their historic range. This reflects and reinforces a general aversion in the ESA\textsuperscript{194} and modern natural resource law to crossing the native/non-native divide.

Other laws also present challenges for non-native translocations. Some states refuse to afford protections under their endangered species statutes to non-native species.\textsuperscript{195} Others mandate that any imported or released species must present little danger to, or not hybridize with, native species.\textsuperscript{196} For federal agencies, even when non-native translocation is

\textsuperscript{189} Id. at 43,966 (stating that introduction was necessary "to provide a source of 'wild' rails for future re-establishment on Guam").

\textsuperscript{190} In addition, some critics contended that the FWS's translocation of a population of the California condor (\textit{Gymnogyps californianus}) to northern Arizona was not within its probable historic range, but the FWS countered that Arizona \textit{did} constitute part of the historic range of the California condor. Endangered Wildlife and Plants: Establishment of a Nonessential Experimental Population of California Condors in Northern Arizona, Final Rule, 61 Fed. Reg. 54,044, 54,053 (Oct. 16, 1996) (codified at 50 C.F.R. pt. 17). In support of this claim, the FWS cited studies showing sightings of the California condor in Arizona in the 1800s, and pointed to other studies that suggested that "the California condor moved back into Arizona as early as the 1700s in response to the introduction of large herds of cattle, horses, and sheep," and that "the species was eliminated by shooting and other forms of human persecution before it could become reestablished throughout the region." Id.

\textsuperscript{191} \textit{U.S. FISH \& WILDLIFE SERV., DESERT PUPFISH RECOVERY PLAN} 20 (1993); Thompson, supra note 182.

\textsuperscript{192} \textit{See supra} notes 109, 111 and accompanying text.

\textsuperscript{193} Telephone Interview with Andrew Thompson, Sw. Fisheries Sci. Ctr., Nat’l Oceanic \& Atmospheric Admin. (June 29, 2009).


\textsuperscript{195} \textit{See} ARIZ. REV. STAT. § 17-296 (LexisNexis 2008); FLA. STAT. § 379.2291 (2008); NEV. REV. STAT. § 503.584(2)(a) (2008); N.C. GEN. STAT. § 113-331(2) (2008).

\textsuperscript{196} \textit{See}, e.g., N.M. ADMIN. CODE tit. 19, § 35.7.15 (2008) (prohibiting the importation of species that may compete or hybridize with native species).
allowed, land management regulations make it essential to maintain native ecosystem integrity and to minimize the influence of the introduction.\textsuperscript{197}

Moreover, many federal land management regulations suggest that substantial reliance on non-native introductions on public lands would subvert core statutory purposes. In wilderness areas, though there may be uncertainty regarding how active management may be,\textsuperscript{198} there is no doubt that any such management must be in furtherance of the Wilderness Act’s purposes of preserving the wild character and natural condition of existing wilderness areas.\textsuperscript{199} As the introduction of a new non-native species almost certainly does not preserve the area in its natural condition, assisted migration in wilderness areas in particular is problematic. Moreover, many regulations interpreting agency authority under the Wilderness Act specifically require the protection or restoration of native populations and natural processes\textsuperscript{200} and the restriction or prohibition of non-native species in those areas.\textsuperscript{201} Perhaps as importantly, some regulations push officials to abstain from any management action in wilderness when there is substantial uncertainty,\textsuperscript{202} and to take action only when necessary and the effects are minimized.\textsuperscript{203}

Yet the goal of protecting native ecosystems against non-native interference extends to all other federal resource lands as well. Each of the federal natural resource agencies makes fundamental to its mission the protection and (when feasible) restoration of native ecosystems and natural processes. The NPS\textsuperscript{204} and the FWS\textsuperscript{205} focus on the preservation

\textsuperscript{197} See, e.g., FWS Manual, supra note 140, pt. 601, § 3.11(C) ("Unless we determine that a species was present . . . under historic conditions, we will not introduce or maintain the presence of that species for the purpose of biological diversity. We may make exceptions . . . in such cases, we strive to minimize unnatural effects and to restore or maintain natural processes and ecosystem components to the extent practicable.").

\textsuperscript{198} See supra notes 160-162 and accompanying text.


\textsuperscript{200} BLM Manual, supra note 130, § 1745.06(H); NPS Management Policies, supra note 146, § 6.3.7.

\textsuperscript{201} See, e.g., BLM Manual, supra note 130, § 1745.06(H) ("In designated wilderness areas, . . . [e]xotics shall not be introduced."); USFS Manual, supra note 122, § 2323.34c(1) (2007) ("Do not stock exotic species of fish in wilderness."); id. § 2323.33a.

\textsuperscript{202} See NPS Management Policies, supra note 146, § 6.3.7 ("Management actions [in wilderness areas] should be attempted only when the knowledge and tools exist to accomplish clearly articulated goals.").

\textsuperscript{203} Id. § 6.3.5.

\textsuperscript{204} See, e.g., id. § 4.1 ("[P]reserving park resources and values unimpaired is the core or primary responsibility of NPS managers."); id. § 4.4.2.2 ("Service will strive to restore extirpated native plant and animal species.").

\textsuperscript{205} FWS Manual, supra note 140, pt. 601, § 3.12.
and restoration to "historic conditions" of existing species and their habitats, and seek to promote "natural diversity" on their lands. The consistent ecological goal of both for Federal Wildlife Refuges and national parks is protecting native ecosystems and species, and the interest of these agencies in endangered and other vulnerable species focuses on native species. Similarly, even with their multiple-use rather than preservation orientation, the BLM and USFS consider their core ecological goal to be sustaining and enhancing native ecological systems and species. On virtually all federal natural resource lands, there is a strong presumption not only in favor of protecting, restoring, and relying on native species, but also in favor of the limitation, avoidance, or removal of non-native species.

206 Id. pt. 601, § 3.6(D) (defining historic conditions as the "[c]omposition, structure, and functioning of ecosystems resulting from natural processes that we believe, based on sound professional judgment, were present prior to substantial human related changes to the landscape").

207 Id. pt. 701, § 1.4(A) ("Natural Diversity: The number and relative abundance of indigenous species which would occur without human interference... The attainment of natural diversity... should be an underlying consideration for all habitat and populations management activities.").

208 Id. pt. 601, § 3.10(B)(1) ("The System's focus is on native species and natural communities such as those found under historic conditions."); id. pt. 601, § 3.14(B); id. pt. 601, § 1.9(A) ("The overarching goal of the Refuge System is to conserve a diversity of fish, wildlife, and plants and their habitats... with a focus on native species."); FWS REFUGE SYSTEM MANUAL, supra note 141, pt. 7, § 8.1; id. pt. 7, § 12.2.

209 See NPS MANAGEMENT POLICIES, supra note 146, § 4.4.1 ("The National Park Service will maintain as parts of the natural ecosystems of parks all plants and animals native to park ecosystems."); id. §§ 4.4.1.2, 4.4.2.5.

210 See, e.g., id. § 4.4.2.3 ("The Service will survey for, protect, and strive to recover all species native to national park system units that are listed under the [ESA]."); id. ("[T]he Service will inventory other native species that are of special management concern to parks... and will manage them to maintain their natural distribution and abundance.").

211 See BLM MANUAL, supra note 130, § 1745.02 (stating as the first two objectives of the BLM's policy on introductions: (1) Ensure that management of native, naturalized and exotic species enhances, restores, and does not reduce the biological and genetic diversity of natural ecosystems; (2) Ensure that the introduction of exotic species is ecologically sound and will not adversely impact natural ecosystems").

212 See 36 C.F.R. § 219.10(b) (2009) ("The overall goal of the ecological element of sustainability is to provide a framework to contribute to sustaining native ecological systems..."). In fact, one of the most recently adopted USFS Manual chapters is dedicated to promoting the "use of native plant materials in revegetation, rehabilitation, and restoration of both aquatic and terrestrial ecosystems." USFS MANUAL, supra note 122, § 2070.2.

213 See, e.g., BLM MANUAL, supra note 130, § 1745.06(A) (stating that native species shall be used in any introduction, transplant, restocking, and reestablishment activity unless various stringent requirements are met); FWS MANUAL, supra note 140, pt. 601, § 3.15(C) ("We do not allow refuge uses or management practices that result in the maintenance of non-native plant communities unless we determine there is no feasible alternative."); FWS REFUGE SYSTEM MANUAL, supra note 141, pt. 7, § 8.1 ("The continued existence, or management of exotic plants and animals on refuge lands will be permitted only if: (A) An exotic species has become established and its elimination, while desirable, is no longer practicable, or (B) An exotic species has become established and maintained on a non-augmented basis for at least 25 years and does not conflict
2. Incongruous with Existing Decentralized Management

Moreover, there is a credible argument that the prevailing approach to natural resource law in the United States fails to provide a reasonably coherent framework for managing efforts like assisted migration for adapting natural resources to the effects of climate change. Though existing statutory provisions and regulatory interpretations may occasionally allow the introduction of non-native species, detractors of the practice can plausibly claim that such regulatory gaps have already led to strange distinctions. For example, the reasons for making it easier for private parties to engage in uncoordinated assisted migration than it is for federal public land management agencies are not obvious. Similarly, it seems incongruous to allow public authorities like the BLM and USFS wide discretion to engage in assisted migration as compared to others like the FWS, which arguably has better technical capacity to manage sensitive introductions. Though the original rationale for providing greater flexibility to BLM may have been because the lands under its jurisdiction were considered less ecologically or aesthetically significant or sensitive, climate change very well may call into question such premises. As these landscapes and the resources therein change, it is not clear that these distinctions make sense.

This paradox is attributable in large part to the fact that the piecemeal natural resource management system developed by Congress over the course of the last century never contemplated the global climate change expected over the next century. Existing natural resource law isolates different types or groups of natural resources (or, in the case of invasive species laws, harms to natural resources) in different management regimes, each managed by separate agencies abiding by different standards and in pursuit of diverse goals. Though undoubtedly not flawless, this approach might work reasonably well if the resources managed under...
these different jurisdictions were indeed largely independent from each other.

However, the existing regulatory framework was not designed to facilitate a wide-scale ecosystem-based or landscape-based approach that blurs the distinctions between legally separate public lands. To be sure, some natural resource scholars and agencies have promoted the development of "ecosystem-based" and "place-based" management that seeks to focus regulators with overlapping jurisdiction to coordinate management centered on particular ecosystems or landscapes. Yet frequent, wide-scale, and synchronized interaction between agencies was simply not contemplated by existing natural resource management laws, so that coordinated ecosystem-based management is still the exception in natural resource governance.

Such a fragmented regulatory system may be particularly ineffectual at addressing the broad, landscape-wide changes in environmental conditions and resulting range shifts for wildlife and vegetation that are likely to accompany climate change over the next century. Landscapes where ecosystems currently exist and are protected may not be suitable for those ecosystems in the near future, and species will need to move to adapt. Many protected species are likely to need to move substantial distances from one designated land category to another. However, they will be constrained not only by topographic or artificial physical barriers, but also by jurisdictional boundaries that lead to their differential treatment in the areas to which they would attempt to migrate (for example, from public to private land, or from BLM land to national parks).


219 See generally supra note 80 and accompanying text (discussing the inadequacy of existing natural resource governance for managing the effects of climate change).

220 See supra notes 44-57 and accompanying text.
Assisted Migration

Accordingly, any coherent effort to engage in the translocation of species to help them adapt to climate change would require a rare degree of collaboration and coordination between agencies that lack clear guidance from existing natural resource management laws. Faced with such climate changes, the fragmentation of regulatory authority and substantial divergence in goals and approaches to resource conservation between jurisdictions become even more significant—and potentially counterproductive. The BLM, for example, manages its lands very differently than the FWS manages Federal Wildlife Refuges, such as by more strongly prioritizing consumptive economic land uses. What happens if BLM decides, consistent with its mission, to introduce a non-native species better adapted to new climatic conditions that then causes harm to species on nearby public lands, such as by adversely affecting a sensitive native species in a Federal Wildlife Refuge?

Alternatively, is a private timber company liable if it legally introduces a non-native tree better adapted to new climatic conditions for timber production that then spreads and has collateral effects on other private or public lands? If a government agency introduces an endangered non-native animal to federal or state land and that animal propagates and migrates to private land, can the private land then become subject to state endangered species law or the federal ESA’s prohibition on take? Does takings law protect the private adjacent landowner onto whose land an introduced, non-native endangered species migrates? Would a successful assisted migration reduce the current obligation to protect an endangered species within its historic range? Do endangered species laws or invasive species laws control if a moved endangered species becomes invasive?

As these few questions illustrate, climate change proliferates and complicates the interactions between existing natural resource laws and adjacent lands that the existing natural resource management system is already ill-equipped to manage. In short, it is true that existing invasive species, endangered species, and public land management laws allow

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221 No precedent exists that addresses whether an introduction of an endangered species outside of its historic range that has a collateral effect on private property could constitute a taking. The closest analog is damage caused by wild horses and burros introduced long ago to North America. See Mountain States Legal Found. v. Hodel, 799 F.2d 1423 (10th Cir. 1986) (holding damage to private lands by wild horses and burros protected by Wild Free-Roaming Horses and Burros Act was not a taking). For government reintroductions within a species’ historic range, at least one court has found that it is not a taking if the reintroduced species migrates onto private land. See Moerman v. State, 21 Cal. Rptr. 2d 329 (Ct. App. 1993) (declining to find a taking when elk reintroduced to their historic range damaged a private landowner’s property); see also Holly Doremus, Restoring Endangered Species: The Importance of Being Wild, 23 HARV. ENVTL. L. REV. 1, 69-90 (1999) (applying constitutional takings jurisprudence to wildlife reintroductions). Other courts have rejected takings claims for damage from non-introduced wildlife. See Christy v. Hodel, 857 F.2d 1324, 1334-35 (9th Cir. 1988) (holding damage caused by bears protected under ESA was not a regulatory taking); Bishop v. United States, 126 F. Supp. 449 (Ct. Cl. 1954) (holding damage to crops by geese protected by Migratory Bird Treaty Act was not a taking).
agencies and private parties to engage in assisted migration. Nonetheless, the general acceptance and use of such a strategy for conserving natural resources is neither anticipated by nor congruent with core goals of natural resource law.

The key question in assessing assisted migration thus becomes not whether assisted migration is feasible, but whether and when it may be normatively desirable. As detailed in Part III, the incongruity of assisted migration with conventional natural resource law should not lead to the dismissal of assisted migration as a strategy for addressing climate change. Rather, it suggests the need to transform the framework and goals of natural resource law to better manage a dynamic and uncertain natural world of which human systems are an inextricable part.

III. The Ethics of Assisted Migration

Though the scholarly literature on assisted migration has primarily focused on questions of scientific viability and legal feasibility, at their core the arguments animating debates about assisted migration are normative—not whether it can be safely and effectively used, but whether it should ever be used as a climate change adaptation strategy. As detailed in this Part, assisted migration ignites long-smoldering tensions in American natural resources policy. Assisted migration commits natural resource management to active and long-term human manipulation and control, running counter to imbedded conservation ideals that aim to allow natural systems to function apart from human interference. Likewise, it pits claims that preserving species diversity is vital for the functioning of human and natural systems against emerging models of resource management that seek to focus on protecting native ecosystems. Finally, assisted migration’s focus on managing resources for future climatic conditions contravenes longstanding public land preservation and restoration goals that view nature as context-specific and historical.

This Part concludes that though scientific uncertainty or predicted harms to biological or man-made systems may sometimes counsel against employing assisted migration in a particular case, categorical ethical claims against the use of assisted migration are unfounded. First, any attempts to safeguard notions of wild and uncontrolled natural systems are belated and artificial in a world in which climate change was caused by human alterations of the environment. Second, though a singular focus on protecting endangered species would be myopic, so would a fixation on maintaining preexisting biota, particularly as such a focus provides little guidance on the appropriate means and ends of resource management in a climate change world. Third, there is scant ethical foundation for categorically arresting the evolution of preexisting ecosystems or
distributing increasing levels of limited resources to actively trying to return ecosystems to what is essentially an arbitrary historic state. Accordingly, legislators and regulators should not reject the use of assisted migration. Rather, they should support and integrate into natural resource decisionmaking robust scientific research that helps reduce uncertainties regarding translocations, identify circumstances where the likely ecological benefits of assisted migration are high compared to the probable costs, and minimize risks of harm from experimental use of this strategy.

A. Challenges to Conventional Natural Resource Management

Assisted migration is unsettling to many because it raises challenges to a number of central features of natural resource law and management. First, assisted migration is premised on a very active human management of and interference with biological systems, eroding a historically influential conservation aim of keeping natural processes uncontrolled and wild. Second, assisted migration would allow resource managers to engage in management activities focused on protecting endangered species but potentially at the expense of preexisting native species and ecological communities. Lastly, assisted migration’s orientation toward anticipating future conditions and transforming resources to maximize future value, however defined, is incongruous with the prevalent conservation objective that seeks to preserve or restore preexisting resources.

1. Attempting To Shield a Wild and Organic Nature

In addressing the effects of climate change on biological systems, natural resource managers ultimately will have the choice of four basic options. The first is doing nothing, allowing existing biological communities and landscapes to change and often decline in ecological function and biodiversity without human management. Another is to rely on passive resource management strategies, such as linking existing preserves with corridors. These strategies would focus on increasing the capacity of native species and biological communities to better accommodate and adapt to climate changes, but would involve little active human management of such interactions. Third, managers could actively manage biological communities and landscapes to preserve them as they were before the onset of anthropogenic climate change. Such strategies would include activities like preventing invasions, engaging in irrigation activities, and regulating biotic interactions over time. Finally, managers could actively manage biological communities and landscapes to convert them into something deemed more compatible with new climatic conditions. One way to understand the argument in favor of assisted migration is that the
last of these options is the best available alternative. Proponents of assisted migration must trust in the capacities of active human management.

However, such a strategy necessarily conflicts with another recognized goal of natural resource management and law that focuses on preventing or minimizing human interference with, or manipulation of, un tarnished natural processes and areas. In this view, what first and foremost should be preserved or restored through conservation management is not a preexisting landscape or ecosystem, but rather the concept of uninhibited nature, that humans are not actively in control. Many, beginning perhaps with John Muir, have emphasized the instrumental and intrinsic value of a wild nature. Numerous commentators have stressed its spiritual value, asserting that wilderness allows individuals opportunities for spiritual restoration through the observance of divine creation or God. Others have focused on nature’s ability to remove the daily stress of life. Some note the economic benefits a wild nature provides to both users and non-users, while others focus on the value that untouched nature provides ecologists as an invaluable template.

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222 See, e.g., LINDA H. Graber, WILDERNESS AS SACRED SPACE 11 (1976) ("The axiom of the wilderness ethic is that wilderness is a manifestation of the Wholly Other from man, and it is to be valued for that reason."); JACK TURNER, THE ABSTRACT WILD 120 (1996) ("Why not work to set aside vast areas where we limit all forms of human influence.... Let whatever habitat we can preserve go back to its own self-order as much as possible. Let wilderness again become a blank on our maps.").

223 See, e.g., John Muir, Alaska (1888), reprinted in NATURE WRITINGS 649, 676 (William Cronon ed., 1997) (claiming that words were not "capable of describing the peculiar awe one experiences in entering these virgin mansions of the icy north, notwithstanding they are only the perfectly natural effect of simple and appreciable manifestations of the presence of God").

224 See, e.g., Wilderness Preservation System: Hearing Before the Subcomm. on Public Lands of the H. Interior and Insular Affairs Comm., Pt. 4, 88th Cong. 1250, 1253 (1964) (statement of Carl W. Buchheister, President, National Audubon Society) ("The preservation of wilderness is therefore one of the noblest challenges the human soul can rise to, because in so doing man looks upon the work of the Creator and says that it is good beyond anything man has been able to manufacture."); RODERICK FRAZIER NAS H, WILDERNESS AND THE AMERICAN MIND 157 (4th ed. 2001) ("As the antipode of civilization, of cities, and of machines, wilderness could be associated with the virtues these entities lacked. ... At a time when the force of religion seemed vitiated by the new scientism on the one hand and social conflict on the other, wilderness acquired special significance as a resuscitator of faith."); John Copeland Nagle, The Spiritual Value of Wilderness, 35 ENVTL. L. 955, 979-84 (2005) (detailing the repeated emphasis on the spiritual significance of wilderness in congressional hearings on the Wilderness Act).

225 See William Cronon, The Trouble with Wilderness, in THE GREAT NEW WILDERNESS DEBATE 471, 483 (J. Baird Callicott & Michael P. Nelson eds., 1998) ("[W]ilderness offers us the illusion that we can escape the cares and troubles of the world in which our past has ensnared us.").

226 See Jan G. Laitos & Rachael B. Gamble, The Problem with Wilderness, 32 HARV. ENVTL. L. REV. 503, 511-12 (2008) ("Non-users also enjoy some very tangible economic benefits that follow from the existence of wilderness: low-impact recreationists who want to access wilderness account for some of the $300 billion in annual retail sales for gear, food, lodging, entertainment, and transportation associated with recreating in America's outdoors. Non-motorized outdoor recreation pumps $730 billion into the United States economy annually, and supports about 6.5 million jobs." (citation omitted)).
to learn from when trying to restore damaged ecosystems. Finally, others have emphasized the value of the mere existence of nature unsullied by humans. At least some of these commentators claim that maintaining or restoring ecological systems to this "natural" state is normatively desirable, morally required, or both.

In natural resources law, this ethical perspective is best embodied by the Wilderness Act of 1964, which protects wilderness lands from active human manipulation. Wilderness areas may "contain ecological, geological, or other features of scientific, educational, scenic, or historical value." However, the defining characteristic of wilderness is that it is "untrammeled... undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions." These areas are protected not primarily for their ecological, geological, scenic, or historical value; they are preserved principally because they are wild, essentially uncontrolled by humankind. The NPS asserts that it prefers to allow wilderness lands to recover naturally from natural disturbances, without human manipulation, though they allow for active management to reverse prior human disturbance of natural conditions. Several public agencies emphasize the value of minimal human interference in non-wilderness areas as well.

This view leans heavily on a dualism between humans and nature. Wild, relatively undisturbed, natural systems are accepted as normatively

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227 CHRISS MASER, THE REDESIGNED FOREST 174 (1988) ("[W]e have to maintain some original, unmanaged old-growth forest, mature forest, and young-growth forest as parts catalog, maintenance manual, and service department from which to learn to practice restoration forestry.").

228 See, e.g., John V. Krutilla, Conservation Reconsidered, 57 AM. ECON. REV. 777, 781 (1967) ("There are many persons who obtain satisfaction from mere knowledge that part of wilderness North America remains . . . ."); Laitos & Gamble, supra note 226, at 510 ("The mere idea of unspoiled wild land in its natural state has value to many individuals, who perceive such lands as a necessary component of human existence on this planet." (citation omitted)).

229 See, e.g., BILL MCKIBBEN, THE END OF NATURE 47 (2006) (noting the inherent human desire to maintain "pristine places, places substantially unaltered by man").

230 16 U.S.C. § 1131(a) (2006); see also supra notes 155-162 and accompanying text (analyzing the permissibility of assisted migration under the Wilderness Act).


232 Id.

233 Id.

234 NPS MANAGEMENT POLICIES, supra note 146, § 4.4.2.4.

235 See id. ("Landscape and vegetation conditions altered by human activity may be manipulated where the park management plan provides for restoring the lands to a natural condition.").

236 See MCKIBBEN, supra note 229, at 48 (discussing "the idea of 'nature,' the separate and wild province, the world apart from man").
good. In contrast, active human management is presumed to be interference or even artifice. Active management in some sense leads to a resource that is really an artifact shaped by human craft, a product of external human agency rather than purely "natural" forces. Active human intervention may be morally appropriate only in exceptional circumstances, such as restoration to reverse prior human disturbance, though some strongly criticize even such efforts.

Assisted migration potentially erodes if not destroys this conception of nature as wild and natural. Assisted migration is expressly active human intervention and management; humans take it upon themselves to control and change biota and biotic interactions. Because assisted migration promotes the removal, introduction, and sustained management of biological units, it ensures an exceptionally active level of natural resource management. Assisted migration challenges the distinction between what is a given of the natural world and what is acceptable for human manipulation.

Some might claim that by engaging in assisted migration, natural resource managers would be treating nature as a "zoological theme

237 See Holmes Rolston, Environmental Ethics: Duties to and Values in the Natural World 238 (1988) ("If we come to a landscape on its own terms, sensitive to its integrity, wild is always a positive predicate."); Michael McCloskey, Changing Views of What the Wilderness System Is All About, 76 DENV. U. L. REV. 369, 375 (1999) ("[T]he key idea of what wilderness is all about is to make sure that humans do not hinder the development of that 'community of life,'—the flora and fauna that grow there.").

238 See Robert Elliot, Faking Nature: The Ethics of Environmental Restoration 79 (1997); Eric Katz, The Ethical Significance of Human Intervention in Nature, 9 RESTORATION & MGMT. NOTES 90, 92 (1991) ("The recreated natural environment that is the end result of a restoration project is nothing more than an artifact created for human use.... Natural individuals were not designed for a purpose. They lack intrinsic functions, and so they are different from human-created artifacts.... Depending on the adequacy of our technology, these restored and redesigned natural areas will appear more or less natural, but they will never be natural—they will be anthropocentrically designed human artifacts.").

239 See, e.g., Andrew Light, Ecological Restoration and the Culture of Nature, in Environmental Ethics: What Really Matters, What Really Works 178, 181 (David Schmidt & Elizabeth Willott eds., 2002) ("We can imagine cases where nature cannot pursue its own interests because of something we have done to it which must be rectified by restoration.... Restoration... may in fact simply be the act of allowing nature to again pursue its own interests rather than shackling it to perpetual human-induced trauma.").

240 See Eric Katz, The Problem of Ecological Restoration, 18 ENVTL. ETHICS 222, 222 (1996) ("[T]he practice of ecological restoration can only represent a misguided faith in the hegemony and infallibility of the human power to control the natural world."); see also Katz, supra note 238, at 90 ("Policies of restoration rest on the assumption that humanity can, and should, repair the damage that human intervention has caused the natural environment.... [T]he idea is an unrecognized manifestation of the insidious dream of the human domination of nature."). But see Light, supra note 239, at 181 ("Even if we agree with Katz that restorations only produce artifacts, can't it still be the case that the harm we cause to nature requires us to engage in [restoration]? It simply does not follow that simply because something is more natural when it is relatively free from human interference that we should conclude that therefore we must always avoid interfering with nature.").
Assisted Migration

park"—a human artifact. It would be impossible to engage in assisted migration and not view the landscape or ecosystem in which the assisted species is introduced as at least in part artifactual, a human creation. Allowing assisted migration would require the tacit approval of active and enduring human manipulation of ecosystems as a principled (or at least acceptable) form of natural resource conservation. Similar to innovations in biotechnology for manipulating genes or embryos, assisted migration raises concerns regarding the hubris of playing God. To the extent that assisted migration could be portrayed as a mechanism for reversing or overcoming a prior human disturbance of a natural system—climate change—it might be possible to navigate around concerns about the propriety of active management of ecosystems. However, the employment of assisted migration would be at least a partial rejection of the intrinsic value of a wild and unmanaged nature. It would be an implicit and likely anthropocentric determination that other considerations are more essential or valuable.

Finally, for some the argument against assisted migration might focus on the increased level of moral culpability that should accompany more active human management of ecosystems in contexts of substantial uncertainty. To some extent, this differentiation is akin to the legal and moral distinctions between responsibility for the commission and omission of an act. In this view, all else being equal, a natural resource

241 Keim, supra note 9.


243 See Christopher Southgate et al., Ascesis and Assisted Migration: Responses to the Effects of Climate Change on Animal Species, 4 EUR. J. SCI. & THEOLOGY 99, 106 (2008) ("[T]o some the movement of animal populations would seem hubristic, a sign of an effort to be sicut Deus. It will smack of the belief that... 'given enough time, effort and investment, we can achieve virtually anything we wish to, and... think that every human problem is susceptible to a technological fix" (quoting Neil Messer, Selfish Genes and Christian Ethics 231 (2007))).

244 Cf. R. Mendez-Treneman et al., Developing Desired Future Conditions with the Landscape Management System: A Case Study of Gotchen Late Successional Reserve, USDA Forest Serv. Proc. RMRS-P-19, at 60, 63 (2001) ("[I]s the professional acting more responsibly by using the best available, incomplete science, or by delaying analyses until complete inventory data are available?"). But see Carmen Tanner & Douglas L. Medin, Protected Values: No Omission Bias and No Framing Effects, 11 Psychonomic Bull. & Rev. 185 (2004) (finding that for some environmental decisions, individuals with certain "protected values" that they shield from tradeoffs were more likely to find a moral obligation to act).

245 Two prominent examples of the legal distinction between acts and omissions are the common law rules sparing a person from criminal and tort liability for failing to act, absent some kind of special relationship or other obligation to act. See, e.g., Model Penal Code § 2.01(3)(b) (1962) ("Liability for the commission of an offense may not be based on an omission... unless... a duty to perform the omitted act is otherwise imposed by law."); Restatement (Second) of Torts § 314 (1965) ("The fact that the actor realizes or should realize that action on his part is necessary for another's aid or protection does not of itself impose upon him a duty to take such action."). For an experimental treatment of the moral distinction between omission and commission, see Mark
management agency is less culpable if it allows a species to go extinct by not engaging in assisted migration than if it engages in assisted migration and the introduced population causes harm. This is not a question of whether the risk of harm of species extinction is greater than the risk of harm of introduction; setting that aside, such a critique asserts that by acting the agency is more culpable than if it does not act.

2. Allowing the Elevation of Endangered over “Native”

In addition, because assisted migration involves the translocation of vulnerable species to new areas, it seems to set arguments for endangered species protection against concerns embedded in natural resource law and management for safeguarding preexisting biological communities. The underlying argument for the use of assisted migration is the longstanding and widely held value of protecting biodiversity. As stated earlier, global climate change threatens the existence of many vital and productive ecosystems and their biological constituencies. Proponents of assisted migration suggest that new active management techniques such as assisted migration will be essential for combating the loss of species and ecosystem health. This line of reasoning draws not only from the extensive literature championing the instrumental and intrinsic value of species diversity, but particularly from the federal ESA’s focus on protecting species from extinction.

Many have emphasized and documented the instrumental benefits to humans of biodiversity and avoiding species extinctions. These include the potential medical or pharmacological benefits derived directly or indirectly from biota. Many also argue that species and genetic diversity


246 The ethical concern might be the moral culpability of the mover not only as to the harm caused to the moved species, but also as to any harm caused to the receiving ecosystem that subsequently occurs.

247 In other words, by engaging in assisted migration, the resource manager assumes responsibility for the harm created that they allegedly would not have had a responsibility for if they failed to act.

248 See supra Part I.


250 See Robert D. Thornton, Searching for Consensus and Predictability: Habitat Conservation Planning Under the Endangered Species Act of 1973, 21 ENVTL. L. 605, 642 (1991) (“[A]ll of the regulatory mechanisms in the ESA are species-specific and are only triggered by the listing of individual species.”); C. Richard Tracy & Peter F. Brussard, Preventing Biodiversity: Species in Landscape, 3 ECOLOGICAL APPLICATIONS 205, 205-06 (1994) (arguing that the ESA’s species-specific approach protects biodiversity better than an ecosystem approach because it has more clearly defined metrics and goals).

251 See, e.g., Norman R. Farnsworth & Djaja Doel Soejarto, Potential Consequence of Plant Extinction in the United States on the Current and Future Availability of Prescription Drugs, 39 ECON.
maintain ecosystem functions and foster long-term stability in natural systems that provide value to humans. This claim relies in part on the precautionary principle: because the detrimental effects of species extinction on ecosystem function and scientific knowledge are potentially considerable and likely irreversible, we should work toward sustaining and preserving all species and prioritize efforts to avert extinctions.

Others focus on the aesthetic or recreational benefits to humans of promoting a diverse natural resource base through the protection of endangered species. Though certainly more subjective, such interests have nonetheless been an important motivation for proponents of assisted

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252 See Kareiva et al., supra note 218, at 15 (defining genetic diversity as "allelic diversity and the presence/absence of rare alleles (foundation for all higher level diversity)," and species diversity as "quantity of species in a given area").

253 See, e.g., Miguel A. Altieri, The Ecological Role of Biodiversity in Agroecosystems, 74 AGRIC., ECOSYSTEMS & ENV'T 19 (1999) (exploring the role of biodiversity in securing crop protection and soil fertility); F. Stuart Chapin III et al., Consequences of Changing Biodiversity, 405 NATURE 234, 238 (2000) ("[T]he loss of rare species may jeopardize the resilience of ecosystems. . . . Species diversity also reduces the probability of outbreaks by 'pest' species by diluting the availability of their hosts."); Kevin Shear McCann, The Diversity-Stability Debate, 405 NATURE 228 (2000) (detailing an empirically supported "diversity-stability" hypothesis that decreasing biodiversity leads to a decrease in ecosystem stability).


255 See MARTIN GORKE, THE DEATH OF OUR PLANET'S SPECIES: A CHALLENGE TO ECOLOGY AND ETHICS 170 (Patricia Nevers trans., 2003) (noting some scientists' view that "extinguishing species is not just a matter of the aesthetic and intellectual interests of a few biologists but . . . deprives science in general of potential knowledge").

256 See, e.g., 119 CONG. REC. 25,675 (July 24, 1973) (statement of Sen. Williams) ("Most animals are worth very little in terms of dollars and cents. However, their esthetic value is great indeed."); Lilly-Marlene Russow, Why Do Species Matter?, 3 ENVTL. ETHICS 101, 111 (1981) (arguing that species can be valued "for their simple beauty, for their awesomeness, for their intriguing adaptations, for their rarity"); Andrew E. Wetzler, The Ethical Underpinnings of the Endangered Species Act, 13 VA. ENVTL. L.J. 145, 169 (1993) (noting the argument that society should "preserve species for their beauty and their majesty").

257 See, e.g., Douglas O. Linder, New Direction for Preservation Law: Creating an Environment Worth Experiencing, 20 ENVTL. L. 49, 68 (1990) ("[T]he argument that natural areas ought to be preserved because of their experiential potential goes far beyond aesthetics and environmentalism. It recognizes not only that natural areas are capable of providing pleasure (the intrinsic value of experience), but that they offer numerous opportunities for the development of character (the instrumental value of experience).").
migration claiming a special connection to a particular vulnerable species. For example, the founder of Torreya Guardians, Connie Barlow, has asserted: "'I kept visiting these spindly trees and thinking, nobody understands you but I do,' ... 'I made a personal commitment to do whatever it took to save them.'" 258 Such arguments undoubtedly have a powerful resonance for many, having historically played a significant role in helping motivate species protection laws such as the federal ESA. 259 Finally, some argue that the ESA is motivated by the conviction that species have intrinsic value regardless of their potential utility to humans. 260 In this view, there is a societal responsibility to take special steps to protect those species most threatened with extinction. 261

Though few scholars have attempted to explore it in the context of climate change, any species-focused justification for assisted migration directly challenges a prevalent theme of natural resource policy that seeks to protect and restore native ecosystems. As explained earlier 262 and further detailed in the next subsection, much of modern conservation law (and public land management in particular) is motivated by the objective of protecting native ecosystems. In particular, much of contemporary American natural resource law is designed to protect species that preexisted European settlement and inhibit those that did not. Though in the past conservation of both endangered species and native ecosystems could be accomplished if endangered species conservation were limited to the species' existing or historic range, assisted migration would promote endangered species conservation to the potential detriment of other preexisting biota.

Moreover, a growing number of interjurisdictional governance regimes have been emerging in response to concerns over regulatory fragmentation and the recognition that effective natural resource

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258 Berdik, supra note 9.


260 RODERICK FRAZIER NASH, THE RIGHTS OF NATURE: A HISTORY OF ENVIRONMENTAL ETHICS 176 (1989) ("[The ESA] gave an unprecedented degree of legal protection to the existence rights of at least some non-human beings ... Utility to humankind was not a criterion for [listing."]); Wetzler, supra note 256, at 174 ("The only justification for species protection that unfailingly protects every species, regardless of its use to humans, is intrinsic value."); id. at 170-73 (detailing considerable congressional support for the ESA based on the intrinsic value of species).

261 See, e.g., ROLSTON, supra note 237 (claiming the last remaining members of a species have more intrinsic value because the species themselves have value, not just the individual members); Ben Bradley, The Value of Endangered Species, 35 J. Value Inquiry 43, 44 (2001) (describing the view "that there may be good reason not to destroy a species even if it has no use for people.")

262 See supra notes 197-213 and accompanying text.
management "requires consideration of connected ecosystem components." These regulatory processes seek to focus on "ecosystem-based" management that emphasizes the importance of protecting ecosystem diversity and health, rather than just focusing on preventing species extinctions. Accordingly, any species-specific focus of assisted migration would run counter to recent trends toward more holistic ecosystem conservation.

In fact, various regulators, conservation groups, and legal scholars have contended that a crucial motivating factor of the keystone conservation law dedicated to species protection—the federal ESA—is the protection of native ecosystems. The ESA does treat species as the focal target for protection. However, it also explicitly mentions ecosystem protection as a purpose for the law. Legislative history indicates that Congress intended ecosystem protection to be a "basic" goal of the Act, and courts have agreed. Congress's 1982

263 See Camacho, supra note 80, at 29-30.
264 See, e.g., Christensen et al., supra note 216, at 665-66 (discussing the goals, values, and scientific bases of ecosystem management); Grumbine, supra note 216, at 27 (tracing the historical development of the concept of ecosystem management); Karkkainen, supra note 216, at 1439-42; Charles H. Peterson et al., National Estuaries, in U.S. CLIMATE CHANGE SCI. PROGRAM, supra note 218, at 40 (proposing reliance on ecosystem-based management for adapting to climate change).
265 See, e.g., Moratorium on the Listing Provisions of the Endangered Species Act: Hearing Before the Subcomm. on Drinking Water, Fisheries, and Wildlife of the Comm. on Environment and Public Works, 104th Cong. 82 (1995) (testimony of Bruce Babbitt, Secretary, Department of the Interior) ("The Endangered Species Act is a warning light. When one species in an ecosystem's web of life starts to die out, all species may be in peril."); George Frampton, Ecosystem Management in the Clinton Administration, 7 DUKE ENVTL. L. & POL'Y F. 39, 40 (1996) (quoting an Interior Department official stating habitat conservation plan (HCP) reforms represent an effort to transform the ESA from "a species-by-species 'emergency room' regulatory tool or safety net into a comprehensive vehicle for regional multi-species habitat planning").
266 See, e.g., Endangered Species Act—Vancouver, Washington: Hearing Before the Task Force on Endangered Species Act of the H. Comm. on Resources, 104th Cong. 67 (1995) (testimony of Mitch Friedman, Executive Director, Greater Ecosystem Alliance) ("[T]he Endangered Species Act is a smoke alarm; habitat destruction is the fire.").
268 16 U.S.C. § 1531(b) (2006) (stating that a central purpose of the ESA is "to provide a means whereby ecosystems upon which endangered species and threatened species depend may be conserved").
270 Id. at 10; see also H.R. REP. NO. 97-835, at 30 ("[T]he purposes and policies of the Act are far broader than simply providing for the conservation of individual species or individual members of listed species.").
271 See, e.g., Babbitt v. Sweet Home Chapter of Cmtyts. for a Great Or., 515 U.S. 687, 699-700 (1995) (stating that the ESA serves to protect vulnerable ecosystems, with listed species

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amendments to the ESA authorizing habitat conservation plans (HCPs) responded to substantial criticisms of the ESA’s species focus, and the subsequent dominance of HCPs in ESA implementation further developed existing ecosystems as a focal unit under the ESA. In this view, endangered species serve as an indicator of native ecosystem health, enabling resource managers to protect ecosystems by gauging the fitness of particularly vulnerable constituents. The primary intent of such laws, from this perspective, is not preventing the extinction of particular species but some other measure of ecosystem health, such as genetic or population diversity or a more holistic ecological “sustainability” or “integrity.”

Therefore, by focusing only on particular species vulnerable to climate change, assisted migration potentially elevates the importance of an individual endangered species over that of native ecosystems. A judgment is being made regarding the relative value of a vulnerable species to be introduced vis-à-vis the biotic communities that already exist and may be harmed by the introduction. In this light, a persistent focus on protecting endangered species through assisted migration arguably contravenes the growing trend in existing natural resource management—including the ESA—that emphasizes native ecosystem protection.

serving as an indicator that the underlying ecosystem is faltering); Or. Natural Res. Council, Inc. v. Kantor, 99 F.3d 334, 339 (9th Cir. 1996).

See Camacho, supra note 267, at 299-300, 304-05 (discussing a re-emphasis on ecosystem protection as a primary motivation of the 1982 ESA amendments authorizing HCPs); J.B. Ruhl, Biodiversity Conservation and the Ever-Expanding Web of Federal Laws Regulating Nonfederal Lands: Time for Something Completely Different?, 66 U. COLO. L. REV. 555, 585-86 (1995) (“[T]he ESA protects only species on the brink of extinction, and does so only on a species-specific basis. . . . The narrow focus of the ESA on harm to and recovery of listed species limits the agencies’ abilities to address broader objectives [and] could lead to decisions adverse to biodiversity.”).

Bradley C. Karkkainen, Adaptive Ecosystem Management and Regulatory Penalty Defaults: Toward a Bounded Pragmatism, 87 MINN. L. REV. 943, 970 (2003) (stating that the HCP program has become “the centerpiece of . . . endangered species and ecosystem conservation policy.”).


See Grumbine, supra note 216, at 29.

See id. at 31.
3. Current Dominance of Historical, Contextual Preservation

Finally, assisted migration also departs from widespread natural resource goals that regard nature as contextual and seek to preserve and restore native biological systems to a historical benchmark. As detailed earlier, the preservation and restoration of native resources to a historic baseline is a core feature of modern American natural resources law. There certainly are historical and current differences in the management of the various federal resource lands. This is particularly so between those lands initially established to be managed for use (for example, general national forest and BLM lands) and those established with an explicit preservation focus (for example, national parks, Federal Wildlife Refuges, and wilderness areas). However, today even national forests and BLM lands are subject to a host of regulations that seek to preserve or restore existing ecological resources to historical conditions through measures that include avoiding, limiting, and removing non-native species.

Much of natural resources management is grounded in an early version of preservation and restoration ecology that is premised on stationarity, "the idea that natural systems fluctuate within an unchanging envelope of variability." Reserves—the fundamental strategy of conventional natural resources management—embODY this model of ecology that emphasizes stasis and natural stability. The few management techniques that seek to revise resource management to integrate the now-dominant "dynamic equilibrium" model of ecology still assume that any variability in ecosystems is bounded and manageable.

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277 See supra notes 204-213 and accompanying text.
278 See supra notes 211-212 and accompanying text.
280 See, e.g., Terry L. Erwin, An Evolutionary Basis for Conservation Strategies, 253 SCIENCE 750, 750 (1991) ("National parks, wildlife refuges, biosphere reserves, military reserves, Indian reservations, and other forms of legally protected areas have been established for aesthetic, political, or practical purposes in the last 150 years."); C.R. Margules & R.L. Pressey, Systematic Conservation Planning, 405 NATURE 243, 243 (2000) ("It is an ancient and widespread human practice to set aside areas for the preservation of natural values."); Rahel et al., supra note 34, at 552 ("Protected areas, such as nature reserves and wildlife refuges, are the mainstay of current conservation efforts...")
281 See J.B. Ruhl, Climate Change Adaptation and the Structural Transformation of Environmental Law, 40 ENVTL. L. (forthcoming 2010) (unpublished manuscript, on file with the Yale Journal on Regulation), available at http://ssrn.com/abstract=1517374 ("Legal regimes that formed before the dynamic equilibrium model was well developed, particularly conservation programs such as the Endangered Species Act, the Wilderness Act, and the National Wildlife Refuge System, to this day depend heavily on the natural stability model of ecosystems and the strategy of setting aside habitat reserves to implement it.") (citations omitted)).
282 See id.
A primary goal of the reserve strategy has been to protect and preserve preexisting resources (such as native biota) within reserved areas while working to remove or keep non-native species out. Natural resource managers are trained in a professional ethic that focuses on preventing or undoing the human alteration of nature. For many, the influential "Leopold Report," commonly considered a foundational (even "scriptural") authority for modern national park management, represents this preservation ethic. One of its most quoted passages recommends as the primary goal of park management that "the biotic associations within each park [should] be maintained, or where necessary recreated, as nearly as possible in the condition that prevailed when the area was first visited by the white man." Active management may be acceptable and even necessary, but generally only to the extent that it is needed to restore the landscape or maintain it in a historic condition.

Similarly, native species have been accepted in natural resource management as a normative, intrinsic good, while only non-native species can be regarded as harmful or invasive. Virtually every definition of "invasive" in the scientific literature requires for the species to be non-indigenous, with some actually treating non-indigenous as synonymous with invasive. Likewise, federal law creates a dichotomy between

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283 Cf. Doremus, supra note 194 (stating that traditional conservation strategies, including preserves, "assume[] that what nature needs most is for people to leave it alone").


287 See Wilderness Soc'y v. U.S. Fish & Wildlife Serv., 353 F.3d 1051, 1062-63 (9th Cir. 2003) (en banc); NPS Management Policies, supra note 146, § 4.4.2.4 ("Natural landscapes disturbed by natural phenomena... will be allowed to recover naturally unless manipulation is necessary to (1) mitigate for excessive disturbance caused by past human effects, (2) preserve cultural and historic resources as appropriate based on park planning documents, or (3) protect park developments or the safety of people.").


289 M.W. Burke & J.P. Grime, An Experimental Study of Plant Community Invasibility, 77 ECOLOGY 776 (1996); Brett J. Goodwin et al., Predicting Invasiveness of Plant Species Based on Biological Information, 13 CONSERVATION BIOLOGY 422 (1999); Ian J. Radford & Roger D. Cousens, Invasiveness and Comparative Life-History Traits of Exotic and Indigenous Senecio Species in Australia, 125 OECOLOGIA 531 (2000).
indigenous species and exotics.\(^{290}\) Federal definitions of invasive include as a necessary prerequisite that the species is non-native.\(^{291}\) In contrast, even if a native species causes serious harm to human health or economic or environmental harm, it is commonly not considered invasive.\(^{292}\)

This preservationist management focus draws on the premise that nature is supposed to be contextual and historical. For many, conservation ethics is rooted in a sense of place\(^{293}\) and is context-specific.\(^{294}\) Even the Torreya Guardians, who ardently argue for the employment of assisted migration for protecting *Torreya taxifolia*, formulate their reasoning for moving the endangered plant north at least partially in restorative terms.\(^{295}\)

Assisted migration directly contradicts this focal management goal of preserving or restoring natural resources to a static historic baseline. Under a policy of assisted migration, management would not rely principally on preserving preexisting biota or excluding non-native species. Rather, managers would deliberately seek to introduce and integrate non-

\(^{290}\) See, e.g., FWS MANUAL, supra note 140, pt. 701, § 1.4(B) (defining indigenous as "[o]riginating in and being produced, growing, or living in a particular region or environment"); NPS MANAGEMENT POLICIES, supra note 146, § 4.4.1.3 ("Native species are defined as all species that have occurred, now occur, or may occur as a result of natural processes on lands designated as units of the national park system ..... Exotic species are those species that occupy or could occupy park lands directly or indirectly as the result of deliberate or accidental human activities. Exotic species are also commonly referred to as nonnative, alien, or invasive species. Because an exotic species did not evolve in concert with the species native to the place, the exotic species is not a natural component of the natural ecosystem at that place.").

\(^{291}\) Exec. Order No. 13,112, 64 Fed. Reg. 6183, 6183 (Feb. 3, 1999); NAT'L INVASIVE SPECIES COUNCIL, MANAGEMENT PLAN: MEETING THE INVASIVE SPECIES CHALLENGE 2 (2001) (defining invasive species as "a species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human, animal, or plant health"); U.S. FOREST SERV., NATIONAL STRATEGY AND IMPLEMENTATION PLAN FOR INVASIVE SPECIES MANAGEMENT 1 (2004) ("A species is considered invasive if ... [i]t is nonnative to the ecosystem under consideration.").

\(^{292}\) See, e.g., NAT'L INVASIVE SPECIES COUNCIL, INVASIVE SPECIES ADVISORY COMM., DEFINITIONS SUBCOMM., INVASIVE SPECIES DEFINITION CLARIFICATION AND GUIDANCE WHITE PAPER 3 (2006) ("While non-migratory populations can cause problems, they are not considered an invasive species because they are native.").

\(^{293}\) See Yi-Fu Tuan, SPACE AND PLACE: THE PERSPECTIVE OF EXPERIENCE 6 (1977) ("What begins as undifferentiated space becomes place as we get to know it better and endow it with value."); James A. Russell & Lawrence M. Ward, Environmental Psychology, 33 ANN. REV. PSYCHOL. 651, 654 (1982) (defining sense of place as "the psychological or 'perceived' unity of the geographic environment"); Daniel R. Williams et al., Beyond the Commodity Metaphor: Examining Emotional and Symbolic Attachment to Place, 14 LEISURE SCI. 29, 31 (1992) ("Physical space becomes place when we attach meaning to a particular geographic locale ....").

\(^{294}\) See, e.g., Holmes Rolston III, Values in and Duties to the Natural World, in ECOLOGY, ECONOMICS, ETHICS: THE BROKEN CIRCLE 73, 86 (F. Herbert Bormann & Stephen R. Kellert eds., 1991) ("A species is what it is where it is."); Williams et al., supra note 293, at 31 (examining sense of place and place attachment to wilderness areas).

\(^{295}\) Dubbing the movement of the plant a homecoming, they allege that "the Torreya is not truly native to northern Florida but was pushed south, along with many species, by the last ice age and then was unable to move north again when the glaciers retreated." Berdik, supra note 9.
native species in direct contradiction with conventional natural resource preservation principles as exemplified by the Leopold Report. The goal of such efforts could no longer be to restore or maintain the landscape as it was prior to human disturbance, or to embed natural resources in a context-specific history.

Assisted migration would strain the natural/man-made and native/non-native poles that exist in natural resource management. Without a native ecological baseline, what does "natural" mean anymore? Native species or ecosystems, long accepted as valuable, would be expected to yield to non-native species in the name of conservation. For those who consider non-native to be synonymous with invasive (and thus harmful by definition), assisted migration would be completely unacceptable. Even those who consider non-native status to be just one prerequisite of invasiveness—in other words, those who would require a species to also be widespread or harmful to be considered invasive—would still have to accept that the value of the introduced non-native species could outweigh that of the native ecosystem.

Assisted migration also could help refute the idea that a place has a unique and organic biota and history. In this critique, assisted migration would not just save a few organisms. At a minimum, assisted migration creates entirely new assemblages of species; at its extreme, assisted migration has the potential to redesign the biota of Earth. Assisted migration makes it virtually impossible to maintain a context-specific intuition of nature. For example, the prevalent association of Yellowstone National Park with its iconic elk, bison, and bears reflected in the park's conservation strategies has little place in a conservation approach that contemplates removal of such fauna to a new landscape. Without a historical ecological baseline, it is unclear what natural resource managers would use to decide what would be an ethical or appropriate management strategy.

296 Cf. Keim, supra note 9 (quoting an ecologist saying, "'[w]e're destroying any semblance of the idea that a place has its own biota and history").

297 See JAMES PRITCHARD, PRESERVING YELLOWSTONE'S NATURAL CONDITIONS, at xviii-xix (1999) (suggesting that Yellowstone's sense of place is based upon its wildlife—bison, elk, bears).

298 See, e.g., BRIAN CZECH & PAUL R. KRAUSMAN, THE ENDANGERED SPECIES ACT: HISTORY, CONSERVATION BIOLOGY, AND PUBLIC POLICY 8 (2001) ("Yellowstone National Park was created in 1872 partly for the purpose of preserving bison and other ungulates that had become rare elsewhere.").

299 Mark Schwartz, Conservationists Should Not Move Torreya taxifolia, WILD EARTH F. (2005), available at http://www.des.ucdavis.edu/faculty/mschwartz/Website%20publications/WildEarth.pdf ("Without a baseline we have no target. Without a target, every kind of management, including those that result in lost native species, is arguably a success.")
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B. In Defense of Assisted Migration

Assisted migration is undoubtedly controversial because it challenges the human-nature dualism, native ecosystem focus, and preservationist goal of contemporary natural resource management. As detailed in this Section, however, these various features of natural resource management make little sense in a world of climate change. It is increasingly evident that human activity is affecting natural systems throughout the globe. Moreover, in a world in which the climate is rapidly changing, committing ever-increasing resources to the preservation or restoration of existing resources and landscapes will be increasingly costly and potentially detrimental to the health of ecological systems.

The goal of maintaining or restoring native ecological systems with respect to a particular historic baseline may previously have been tenable and even advantageous as a rough heuristic for limiting resource exploitation. However, climate change suggests that it might be wasteful and even counterproductive. Rather than unconditionally rejecting assisted migration as a potential climate change adaptation strategy, scientists should focus on developing scientific data to assist analyses of the risks and benefits of assisted migration in particular circumstances. More broadly, agencies and policymakers should seek to develop regulatory institutions and goals that better reflect the realities of a dynamic world in which human effects and ecological change are inescapable.

1. Active Management for Species Protection

Arguments based on a normative commitment to keeping natural systems wild and uncontrolled—and thus the binary distinction between humans and nature—lack persuasive power, particularly in an era of anthropogenic climate change. Humanity is inseparable from nature. Humans have helped shape natural systems for tens of thousands of years, and there are few if any examples of nature today that are pristine

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300 Mathis Wackernagel & William Rees, Our Ecological Footprint: Reducing Human Impact on the Earth 4 (1996) ("[T]he human enterprise cannot be separated from the natural world even in our minds because there is no such separation in nature. In terms of energy and material flows, there is simply no 'out there'—the human economy is a fully dependent sub-system of the ecosphere."); J.B. Ruhl, The Pardy-Ruhl Dialogue on Ecosystem Management, Part IV: Narrowing and Sharpening the Questions, 24 Pace Envtl. L. Rev. 25, 30-31 (2007) (explaining "naturalness" and the "natural/unnatural dichotomy" as a subjective human conception).

301 See Stephen Bujansky, Nature's Keepers: The New Science of Nature Management 103-11 (1995) (explaining that native populations shaped what we now know as American flora and fauna by regularly burning large portions of the landscape); William Tucker, Is Nature Too Good for Us?, in Taking Sides: Clashing Views of Controversial Environmental Issues 34, 42 (Theodore G. Goldfarb ed., 7th ed. 1997) ("Wilderness today means the land after the Indians have been cleared away but before the settlers have arrived."); see also Carol Kaesuk Yoon, Rain Forests
and independent from humanity. The signatures of humanity exist even in deep and remote locations. Indeed, anthropogenic climate change itself has already ensured human interaction with virtually every natural system on the planet.

As such, human involvement in natural systems is inevitable. Though there are extensive ecological and other benefits from natural resource conservation, one of those benefits cannot be that wilderness and other undeveloped landscapes remain unaffected by humanity. The critical query cannot be whether human activities, and in particular natural resource management strategies such as assisted migration, interact with and affect nature—they unquestionably do. Rather, the important analysis is whether the effects of a particular human activity are, on the whole, beneficial. Natural resource management must seek to minimize the negative (and maximize the positive) consequences of human activities on natural systems. In view of this, assisted migration could be a defensible adaptation strategy in certain circumstances.

The dualist critique of assisted migration as interference with nature becomes even weaker when one considers that the alternative strategies to assisted migration could be just as intrusive and dangerous. Management of ecosystems to preserve them as they were before the onset of anthropogenic climate change is as active a form of management as the intentional movement of species, as would be any attempt to restore ecosystems to a preexisting state. Furthermore, though less active than assisted migration, there is scant evidence that creating corridors is categorically less likely to lead to ecological harm to the receiving ecosystem than active movement by humans via assisted migration.

See as Shaped by Human Hand, N.Y. Times, July 27, 1993, at C1 (reporting that "virgin" forests were cleared and burned hundreds or thousands of years ago by humans).

See, e.g., Jonathan Baert Wiener, Beyond the Balance of Nature, 7 Duke Envtl. L. & Pol'y F. 1, 12 (1996) ("Meanwhile, there is no untainted realm to preserve, because humans have in effect already touched it all. . . .").

See, e.g., Daniel B. Botkin, Discordant Harmonies: A New Ecology for the Twenty-First Century 194 (1990) ("[T]here is no longer any part of the Earth that is untouched by our actions in some way. . . ."); Alyson C. Flourny, Restoration Rxs: An Evaluation and Prescription, 42 Ariz. L. Rev. 187, 198 (2000) ("[H]umans continually affect and change the environment around us. Unless we choose to stop breathing, we involuntary change the atmosphere with every breath.").

See Robert R.M. Verchick, Steinbeck's Holism: Science, Literature, and Environmental Law, 22 Stan. Envtl. L.J. 3, 16 (2003) ("E[e]very ecological system on the planet has been touched by human conduct, directly or indirectly, whether by genetic manipulation, air and water pollution, climate change, or farming. There is nothing truly pristine left to protect.").


Similarly, though less intrusive than active strategies like assisted migration, passive resource management strategies such as setting aside land preserves are still a form of human interaction with and influence on natural systems. Some in fact argue that wilderness areas are "the most astonishingly unnatural places on earth" because society takes "human beings out of nature altogether and mak[es] wilderness of it." In short, any adaptation strategy—and even the absence of an express adaptation strategy for species conservation—will have substantial effects on ecological systems. A human-nature dichotomy simply is not a useful standard for evaluating resource management strategies.

In fact, though some may consider the feature of active human involvement to militate against the use of assisted migration, there actually is a credible argument for an ethical duty to at least consider more active approaches like assisted migration as a way to reverse the effects of climate change. This is borne out by a closer review of the legal and ethical distinction between responsibility for omission and commission. Though the law may acknowledge a general distinction between responsibility for acting and failing to act, this is certainly not the case when there is a special relationship or other obligation to act. At least government agencies, established with the duty of conserving shared natural resources for the public, could not rely on a decreased culpability for failing to act. In addition, because current global climate change is at least in part anthropogenic, there may in fact be an affirmative moral and legal duty for public entities to act. In contexts involving preceding acts that led to harm,
some have reasoned that there is an affirmative duty to take reasonable steps to reverse or mitigate the negative effects of the initial act. As such, doing nothing or taking less aggressive steps to reverse the harms of climate change might be more morally problematic than the intentional movement of species out of their native range.

2. Balancing Endangered and Preexisting Species

As detailed earlier, the experience of the federal ESA has demonstrated that a solitary focus on protecting endangered species is misguided. However, categorical ethical claims against the use of assisted migration based on a fidelity to keeping native ecosystems intact are similarly problematic. An absolutist approach that focuses on maintaining currently existing (or restoring previously occurring) biota is of suspect value for managing perpetually changing ecological communities, particularly in light of the rapid and convulsive effects of global climate change.

The lack of a broader management focus has been an insightful critique of endangered species management laws, but establishing a consensus on what ecosystem management is and should be has been very elusive. The definition of ecosystem management in the academic literature is contested, and professed applications of it by regulatory

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311 See Richard A. Epstein, A Theory of Strict Liability, 2 J. LEGAL STU. 151, 191-92 (1973) (arguing that in any circumstance in which an individual creates a risk and then fails to take steps to prevent the possibly resulting danger, that individual should be liable); Damien Shiff, Samaritans: Good, Bad and Ugly: A Comparative Law Analysis, 11 ROGER WILLIAMS U. L. REV. 77, 85 (2005) ("The common law made allowances for a duty to rescue in the following circumstances: (1) where a special relationship existed (e.g., spouse to spouse, parent to child, or landowner to licensee or invitee); (2) where a contract or statute imposed an affirmative duty upon the rescuer; (3) where the rescuer had voluntarily assumed the duty to rescue; and (4) where the rescuer had created the danger."); see also W. PROSSER, THE LAW OF TORTS § 56, at 338-43 (4th ed. 1971) (detailing the various special relationships that give rise to a legal duty).

312 See supra notes 263-276 and accompanying text.

313 Grumbine, supra note 216, at 28; see also CHARLES W. FOWLER, SYSTEMIC MANAGEMENT: SUSTAINABLE HUMAN INTERACTIONS WITH ECOSYSTEMS AND THE BIOSPHERE 85 (2009) ("Ecosystem management has no universally accepted definition"); Jerry F. Franklin, Ecosystem Management: An Overview, in ECOSYSTEM MANAGEMENT: APPLICATIONS FOR SUSTAINABLE FOREST AND WILDLIFE RESOURCES 21, 26 (Mark S. Boyce & Alan Haney eds., 1997) ("Many interpretations of ecosystem management exist, as suggested by the diversity—and contrasting goals—of stakeholders, professional groups, and decision makers who have adopted the label."); Oliver A. Houck, On the Law of Biodiversity and Ecosystem Management, 81 MINN. L. REV. 869, 873 (1997) ("Any proponent of... ecosystem management faces several challenges from the start. The first is establishing what [this] term means."); Steven L. Yaffee, Three Faces of Ecosystem Management, 13 CONSERVATION BIOLOGY 713, 714 (1998) ("If there is one thing about ecosystem management with which people agree, it is that the term means different things to different people."). In response to this definitional problem, a bill was proposed in 1995 in the United States Senate to create an "Ecosystem Management Commission" to, among other things, develop a definition of ecosystem management. See Ecosystem Management Act of 1995, S. 2189, 103d Cong. § 217 (1995).
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authorities vary considerably.314 Many interpretations rely on procedural themes that may be quite valuable but do not provide substantive limitations or guidance on what to focus on in managing an ecosystem.315 Moreover, those interpretations of ecosystem management that do discuss substantive themes emphasize concepts which are vague, pliable, and particularly confounding in light of climatic change. These include the protection of ecological or biological integrity or health,316 sustainability,317 and broadening the management focus to include not only species but also genetic, population, and ecosystem diversity.318

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314 See Grumbine, supra note 216, at 29 ("Ecosystem management has not been uniformly defined or consistently applied by federal or state management agencies."); Houck, supra note 313, at 883-929 (describing the USFS's varied application of ecosystem management principles); cf. Rebecca W. Thomson, Ecosystem Management: Great Idea, but What Is It, Will It Work, and Who Will Pay?, 9 Nat. Res. & Env't 42, 70-71 (1995) ("Much federal effort has already been spent on determining the appropriate geographic scale [for managing ecosystems]. Various agencies have used different approaches to create maps of 'ecosystems.' None of the maps agree in the number or location of ecosystems . . . ."). Some agencies have opted to use different terminology because of the elusiveness of ecosystem management. See Ecosystem-Based Fishery Management and the Reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act: Oversight Hearing Before the H. Subcomm. on Fisheries Conservation, Wildlife and Oceans of the Comm. on Resources, 107th Cong. 10 (2001) (statement of David L. Fluharty, Chairman, National Marine Fisheries Service Ecosystems Principles Advisory Panel) ("The Ecosystem Principles Panel deliberately chose the term 'ecosystem-based fisheries management,' as opposed to 'ecosystem management,' because we felt that that was something we could actually get our hands around . . . .").

315 For example, the Ecological Society of America's Committee on the Scientific Basis for Ecosystem Management defines ecosystem management as "management driven by explicit goals, executed by policies, protocols, and practices, and made adaptable by monitoring and research based on our best understanding of the ecological interactions and processes necessary to sustain ecosystem composition, structure, and function." Christensen et al., supra note 216, at 665. But see Nagle & Ruhl, supra note 217, at 335 ("Of course, this [definition] only begs the question: What are the goals, policies, protocols, and practices of ecosystem management?"); see also Fowler, supra note 313, at 85 ("[M]ost definitions [of ecosystem management] are primarily lists of factors that need to be taken into account, but without means to find balance in the face of conflict."); Thomson, supra note 314, at 42 (describing ecosystem management as a "process to analyze resource allocation decisions"). Definitions of ecosystem management often contain such concepts as interjurisdictional collaborative management, improving data management and monitoring, more adaptive management, and changes in regulatory structure and methods of operation. See Grumbine, supra note 216, at 29-31.


317 Nat'l Research Council, Sustaining Marine Fisheries 15 (1999) ("Although ecosystem management has many definitions, sustainability is a central part of most of them."); Christensen et al., supra note 216, at 666 ("[S]ustainability must be the primary objective."); Franklin, supra note 313, at 27 ("[F]undamentally, ecosystem management is managing ecosystems so as to assure their sustainability."); Richard Haeuber & Jerry Franklin, Perspectives on Ecosystem Management, 6 Ecological Applications 692, 693 (1996) ("Sustainability is at the core of ecosystem management, its essential element and precondition."). The concept of sustainability faces its own definitional problems. See, e.g., Bryan G. Norton, Sustainability: A Philosophy of Adaptive Ecosystem Management 47 (2005) ("Often . . . one hears the fear expressed that sustainable, used by so many to evoke so much, has been rendered meaningless by the very inclusiveness that makes it a

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A core problem with such a focus is that because ecosystems are always in flux, any attempt to manage such dynamic systems is fraught with ambiguity. As difficult as managing a resource area for a particular species may be, developing broadly accepted standards and limitations for managing for the integrity or sustainability of a multitude of genotypes, populations, species, and ecosystems is an exponentially greater challenge. Some are thus understandably concerned that a rejection of managing for particular species in favor of ecosystem management can be a recipe for standardless resource regulation.

Some understandings of ecosystem-centered natural resource management provide sufficient flexibility to allow the use of assisted migration when beneficial to humans. These interpretations explicitly include the integration of human-centered values as an important part of ecosystem-based management. For such approaches, there is an express politically useful, large-umbrella characterization of environmentalists’ goals and objectives;
recognition that humans are and should be significant influences on
natural systems. In such a view, the categorical rejection of assisted
migration becomes impossible except in the unlikely event that one could
establish that under no circumstances could the benefits to humans of
introducing a non-native endangered species outweigh the risks.
Otherwise, the only way to determine if the use of assisted migration is
warranted is through a case-specific analysis that considers the social and
ecological benefits and costs of translocating a particular species to a
particular site.

Other attempts to elaborate on these substantive themes of ecosystem
management emphasize preservation and even reintroduction to protect
naturalness, natural disturbance regimes, the representation of
ecosystems across natural ranges of variations, or viable populations of
native diversity. These interpretations thus emphasize promoting the
preservation or restoration of nativity, using some predetermined historic
baseline to guide resource management strategies. However, given that
ecosystems have been and “naturally” are continually in flux—often as a
result of human activity—it is difficult to identify an unassailable ethical
basis for categorically dismissing the use of assisted migration as
unnatural. Any such rejection would more soundly be based on a judgment
that, in the particular circumstances, maintaining the assemblage of
present species is of more value (historic or otherwise) than the
assemblage that would exist with the introduction of a new endangered
species. Yet, as is detailed in the next subsection, such a determination will
be increasingly difficult as climate changes cause ecological systems to
transform.

3. Anticipatory Management for Impending Change

Though the preservation or restoration of landscapes may promote
scientific, aesthetic, or other human interests, categorically freezing biota
at a particular period in the past or future has no objective ethical
foundation. In fact, climate change will make accomplishing preservation
or restoration objectives increasingly difficult. Any sensible analysis of
assisted migration should consider the diminishing gains and escalating
costs of preserving and restoring to a historic baseline before rejecting the
use of assisted migration.

680 (noting that managers must “appreciate the immediate needs of the people presently living on
the landscape” in order to “find solutions that address both human and wildlife needs”).
322 See Goldstein, supra note 316, at 248.
324 See supra notes 300-304 and accompanying text.
One might reasonably question the prudence of relying on a natural resource management approach that seeks to restore past (or preserve existing) ecosystems or landscapes as inert and unchanging phenomena.\textsuperscript{325} Many commentators have discussed how much of conventional natural resource law and management historically has focused on maintaining the "balance of nature,"\textsuperscript{326} fallaciously treating ecosystems as static assemblages.\textsuperscript{327} Ecosystems are now universally understood as naturally dynamic, not in equilibrium but rather ever-changing.\textsuperscript{328} Instability may even be necessary for many species to exist.\textsuperscript{329} As such, any attempt to identify and preserve ecosystems rooted in the notion of an original steady state is problematic.\textsuperscript{330} Thus, ethical claims against assisted migration based on it being antithetical to the preservation or restoration of native ecosystems appear to be incongruous with prevailing knowledge of ecological systems.

\textsuperscript{325} Cf. Karkkainen, supra note 217, at 196-97 ("[W]e have constructed an architecture of laws and management systems that are poorly matched to the challenge of managing ecosystems as complex dynamic systems.").

\textsuperscript{326} A. Dan Tarlock, The Nonequilibrium Paradigm in Ecology and the Partial Unraveling of Environmental Law, 27 LOY. L.A. L. REV. 1121, 1122-23 (1994) ("The underlying ecological justification for the land ethic is the equilibrium paradigm or, as it is crudely and popularly called, the balance of nature... Twenty-five years after this paradigm was incorporated into law, it—and thus the basis for the core of biodiversity protection law—is now unraveling... [T]he equilibrium paradigm has been rejected in ecology and replaced with a complex, stochastic nonequilibrium one.").

\textsuperscript{327} See, e.g., Robert B. Kelker, Public Lands and Law Reform: Putting Theory, Policy, and Practice in Perspective, 2005 UTAR L. REV. 1127, 1196 ("Ecosystem management acknowledges that resource systems are dynamic and nonequilibrium in character, while traditional resource management has taken a more static and deterministic view of the landscape."); Reed F. Noss, Some Principles of Conservation Biology, as They Apply to Environmental Law, 69 CHI.-KENT L. REV. 893, 893 (1994) ("[C]lassical preservationist approaches to conservation, to the extent that they attempt to hold nature static, do not reflect realities of nature.").

\textsuperscript{328} See BOTKIN, supra note 303, at 10 (explaining that contrary to the initial views of ecologists who believed they could identify "highly structured, ordered, and regulated, steady-state ecological system[s]," ecologists now believe that "at the levels of populations and ecosystems... [c]hange now appears to be intrinsic and natural"); C.S. Holling et al., Science, Sustainability and Resource Management, in LINKING SOCIAL AND ECOLOGICAL SYSTEMS: MANAGEMENT PRACTICES AND SOCIAL MECHANISMS FOR BUILDING RESILIENCE 342, 354 (Fikret Berkis & Carl Folke eds., 1998) ("The linear, equilibrium-centered view of nature no longer fits the evidence, and is being replaced by a nonlinear, multi-equilibrium view.").

\textsuperscript{329} See, e.g., David Farrier, Conserving Biodiversity on Private Land: Incentives for Management or Compensation for Lost Expectations?, 19 HARV. ENVT'L. L. REV. 303, 325 (1995) ("There is scant evidence that ecosystems were ever in equilibrium, and instability may be responsible for the continued existence of many species.").

\textsuperscript{330} See Houck, supra note 313, at 873-83 (detailing the practical difficulties of ecosystem-based management); Donald Worster, Nature and the Disorder of History, in REINVENTING NATURE 65, 143 (Michael E. Soulé & Gary Lease eds., 1995) ([T]he science of ecology has been hoist on its own petard by maintaining, as many did during the middle of this century, that natural communities tend toward equilibrium. Current ecological thinking argues that nature at the level of local biotic assemblages has never been homeostatic. Therefore, any serious attempt to define the original state of a community or ecosystem leads to a logical and scientific maze.").
Indeed, climate change is likely to alter ecosystems in fundamental ways, causing many new, no-analog biotic assemblages and communities to form. Why would these newly formed communities be natural and moral, while introducing species into such communities would be artificial and unethical—particularly if members of an introduced species might have migrated to such a location had they not been trapped by human-caused dispersal barriers (such as agriculture and urban areas)?

Accordingly, the possibility of intervening in ecological systems through assisted migration to improve their function or to advance other public values should not be unconditionally rejected on ethical grounds.

A corollary of this contention is linked with previously stated concerns about relying on a simplistic dualism of nature and humanity: the pervasive native/non-native distinction is a short-sighted human construct that only accounts for a tiny fragment of evolutionary time. Viewed under a longer timeline, humans are simply a part of nature, and species movements in and out of particular landscapes are unexceptional and widespread. Consequently, the critical inquiry is not whether human activities such as assisted migration tamper with nature or depart from a historical norm; rather, the important objective is to minimize the negative and maximize the positive consequences from resource management strategies and other human activities.

Accordingly, scientists and regulators should not categorically reject assisted migration. As further detailed in the next Part, scientists should work to substantiate the ecological benefits and risks of assisted migration, and legislators must develop a regulatory framework that integrates such scientific information into management decisions. More importantly, natural resource law must evolve to recognize that natural systems—as well as information about them—necessarily change over time, and that assessments of their value unavoidably involve judgments that are not exclusively a scientific inquiry.

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331 See supra note 56 and accompanying text.
332 McKibben, supra note 229, at 64 ("The British scientist James Lovelock wrote some years ago that 'our species with its technology is simply an inevitable part of the natural scene,’ nothing more than mechanically advanced beavers. In this view, to say that we ‘ended’ nature, or even damaged nature, makes no sense, since we are nature, and nothing we can do is ‘unnatural.’"); Nash, supra note 224, at xii ("Friends of wilderness should remember that in terms of the entire history of man’s relationships with nature, they are riding the crest of a very, very recent wave."); Wiener, supra note 302, at 15 ("These dichotomies [for example, human/nature] are normative fictions which break down amidst the complex realities of dynamic nature and dynamic society. The categories are unhelpful in any sophisticated context.").
333 Wiener, supra note 302, at 14 ("Preservation inescapably entails modification: protecting a landscape or a species, or walling off human contact, curtails or replaces the dynamic influences that the landscape or species would otherwise confront, and induces it to evolve in a new way. Change is inevitable, and what matters is not the false choice of preservation versus change, but the real choice of which changes are benign and which are adverse.").
IV. Toward an Assisted Migration Framework

As argued above, human involvement in natural systems is already occurring and inevitable. As climate change places endangered species and the constituents of historical ecological communities increasingly in competition with each other, any climate change adaptation strategy like assisted migration should seek to minimize the harm and maximize the benefits of human management of biotic resources. More case-specific risk assessments that integrate the relative ecological and social value of these various constituents inevitably will need to occur.

In certain circumstances, the judicious use of assisted migration might be the best alternative for balancing biodiversity and other ecological values as climate changes. There is already substantial evidence that its use would provide benefits beyond more passive management strategies to species likely to be squeezed by climate change, and there are a number of identifiable factors that are likely to be influential in any assessment of assisted migration. However, there are also a multitude of uncertainties that will affect the suitability of assisted migration in a particular case. The focus of management efforts must be to minimize uncertainty regarding the risks and benefits of assisted migration and to articulate and evaluate the values of an ecosystem and its current and potential components. This Part sets forth an initial conceptual framework for such analyses, recommends a research agenda for developing relevant data, and argues for the development of a regulatory system that manages uncertainty and cultivates agency learning over time.

A. Alternative Adaptation Strategies

So when would assisted migration be a reasonable strategy? Passive management strategies—most notably, maintaining preserves, as well as creating corridors to increase connectivity between preserves—often may be preferable to more active approaches like assisted migration. In many circumstances, there may be less of a risk of damage to natural systems from a less intrusive activity. However, there are substantial reasons to believe that active management strategies like assisted migration may be the best alternative for promoting ecosystem health and function in some circumstances.

Though data is undoubtedly limited, it is likely that, at least for some species, assisted migration will be necessary to survive the effects of climate change and other human-induced environmental stressors. Passive management strategies are poorly matched to climate change and will insufficiently safeguard biodiversity. Reserves, which rest on the assumption that nature can largely be insulated from the impacts of
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humans, have been a dominant strategy in modern resource conservation, used to combat conventional environmental stressors such as over-exploitation of resources, introductions of invasive exotic species, and human-induced habitat loss.\textsuperscript{334} Creating reserve networks can help (and has helped) address these conventional stressors because the harm of such stressors to resources can be largely abated by simply segregating the resources from such human activity.\textsuperscript{335}

In contrast, reserves are not immune to many of the projected effects of climate change, such as alterations in precipitation rates or air or water temperature.\textsuperscript{336} Species are already experiencing substantial stress from relatively minor temperature changes over the past few decades, and the biodiversity and ecosystem function of preserves will be subject to considerably more harm as climate change continues. In fact, dedicated preserves may actually become inhospitable to the natural resources they were initially set up to protect. Though reserves are likely to remain an important feature of natural resource management in the future, they will not be able to insulate native resources within them from climate change. To maintain stable and modestly healthy ecosystems, some type of active management may be necessary for many reserves to moderate the effects of climate change.

Furthermore, migration corridors,\textsuperscript{337} as the most common alternative offered to assisted migration as a natural resource adaptation strategy, will not be feasible or helpful in many circumstances.\textsuperscript{338} Though corridors may increase the opportunity for some species to migrate,\textsuperscript{339} they will be ineffective for those with slow dispersal rates or in isolated areas.\textsuperscript{340} Furthermore, it will often be impracticable to develop corridors for many

\textsuperscript{334} See Rahel et al., supra note 34, at 557 ("A dominant management paradigm for species of conservation concern is to isolate them in a reserve and hope that the species will prosper in the absence of human disturbances.").

\textsuperscript{335} Id.

\textsuperscript{336} See Lee Hannah et al., Protected Area Needs in a Changing Climate, 5 FRONTIERS ECOLOGY & ENV'T 131 (2007) ("Climate change could ... result in species range dynamics that reduce the relevance of current fixed protected areas in future conservation strategies.").

\textsuperscript{337} See, e.g., Andrew F. Bennett, Linkages in Landscape: The Role of Corridors and Connectivity in Wildlife Conservation (2d ed. 1999) (discussing the value of corridors); Larry D. Harris & Jerrold Scheck, From Implications to Applications: The Dispersal Corridor Principle Applied to the Conservation of Biological Diversity, in Preserving Communities and Corridors 11 (G. Mackintosh ed., 1989) (asserting the biological bases and success of corridors); Simberloff et al., supra note 50, at 495-96 (detailing rationales for corridors).

\textsuperscript{338} See Simberloff et al., supra note 50, at 498-501 (discussing disadvantages of corridors).

\textsuperscript{339} See, e.g., Minna-Liisa Rantalainen, Testing the Usefulness of Habitat Corridors in Mitigating the Negative Effects of Fragmentation: The Soil Faunal Community as a Model System, 25 APPLIED SOIL ECOLOGY 267 (2004) (noting that the population growth of enchytraeid worms was aided by the presence of corridors).

\textsuperscript{340} See supra note 50 and accompanying text.
species to overcome large-scale barriers such as cities or extensive monoculture. In such circumstances, active and aggressive management will be needed to prevent extinctions, minimize loss of genetic diversity, improve ecosystem functioning, or to address "broader human-caused disequilibria with nature." Thus, at least in some cases an active strategy like assisted migration is likely to be a defensible and possibly essential alternative for preventing extinction expected to otherwise result from rapid climate change.

B. A Provisional Standard for Experimental Translocations

The success of any attempt at assisted migration will be heavily influenced by a number of traits that can be identified prospectively—even if currently there is insufficient information to evaluate whether most of these traits militate toward the use of assisted migration for a particular case. These of course include the technical feasibility and economic cost of undertaking a translocation. In addition, a number of biological characteristics of candidate species are likely to shape the potential benefit and harm of a translocation. Such features include: (1) the extent to which the species is or will be at risk of decline or extinction; (2) the species' mobility or capacity for dispersal; (3) the species' taxonomic distinctiveness, functional uniqueness, or its "future evolutionary potential"; (4) the type of species (for example, if it is flora or fauna, terrestrial or aquatic); and (5) the species' ecological role, such as

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341 See supra notes 56-57 and accompanying text.
342 McLachlan et al., supra note 6, at 298. Some also claim assisted migration can serve as a powerful rhetorical device. One of the few articles discussing in any length the ethical dimensions of assisted migration asserts that it could "make yet more plain to those who influence the course of the most carbon-intensive economies in the world just how vital a change of policy has become." See Southgate et al., supra note 243, at 103.
343 See Hoegh-Guldberg et al., supra note 3, at 346; Hunter, supra note 7, at 1357; Richardson et al., supra note 5, at 9722.
344 See Hoegh-Guldberg et al., supra note 3, at 345; Hunter, supra note 7, at 1356; Richardson et al., supra note 5, at 9722.
345 See, e.g., Hunter, supra note 7, at 1356 ("All other things being equal, species that appear unlikely to disperse and colonize on their own because of limited vagility will be prime candidates for assistance.").
347 See Richardson et al., supra note 5, at 9722.
349 Certain taxa, such as most terrestrial plants, will be relatively easy to translocate, control, and manage, though some prolific seed producers are likely to be more problematic. Due to the difficulty of controlling dispersal, most aquatic species and predatory mammals will also be particularly risky candidates for assisted migration. Cf. Hunter, supra note 7, at 1357 ("[T]he most
whether it is a generalist or specialist, whether it is a dominant or keystone species, or whether it is heavily dependent on coexisting with another species (for example, mutualism relationships).\footnote{350}{See, e.g., id. ("Species that have major ecological roles (i.e., dominants, keystones, or strong interactors)\ldots are probably riskier to move than those whose role is largely redundant with other species." (citation omitted)).}

Similarly, the potential benefit or harm of a translocation will likely be affected by a number of physical or biological characteristics of candidate sites. These would likely include: (1) projected climate and other abiotic conditions at the site and their likely compatibility with the candidate species; (2) the site’s biotic environment and its likely compatibility with a candidate species (such as the existence of an ecological niche left absent by an extirpated species that the candidate species could fill,\footnote{351}{Id. ("Many ecosystems are not pristine because one or more species have been extirpated. In these cases, would it be acceptable to introduce a ‘climatic refugee’ that might fill the role of the extirpated species?"))}; (3) the phylogenetic uniqueness of the target site or biota therein;\footnote{352}{Cf. Willis et al., supra note 7, at 48 (stating that butterfly species in a translocation experiment "were released into communities that contain species with which they already coexist elsewhere, so negative consequences of the translocations for other species were extremely unlikely.")}; (4) the level of human presence or prior human “disturbance” at the candidate site;\footnote{353}{See Richardson et al., supra note 5, at 9722. For example, in general the more geographically isolated the site, the easier to contain any unforeseen harmful effects of a translocation. See Hunter, supra note 7, at 1357. However, a more geographically isolated site is also likely to consist of more unique biota and be more evolutionarily isolated (and thus potentially more vulnerable to introduced species). See id.}; (5) the extent to which the target species can be removed from or at least contained on the site, which bears on the reversibility of the introduction;\footnote{354}{See Hunter, supra note 7, at 1357 (stating that human-dominated landscapes like a mine restoration site would be more acceptable as a target site for assisted migration than wilderness reserves).}; and (6) the ecological health or stability of the receiving ecosystem, with more ecologically robust sites in general more capable of absorbing newly introduced species as compared to those of poor ecological fitness.\footnote{355}{For other possible criteria that I and others have articulated, see Richardson et al., supra note 5, at 9722.}

These ecological criteria may not be exhaustive,\footnote{356}{Hunter, supra note 7, at 1357 ("[A]ll other things being equal, a species-rich ecosystem may be less likely to be disrupted by a translocation than a species-poor ecosystem.")}; and new information obtained through future experience with translocation and the effects of climate change may suggest others.

egregious examples of invasive exotics (at least as measured by extinctions) are generally animals that consume other species into oblivion").

\footnote{350}{See, e.g., id. ("Species that have major ecological roles (i.e., dominants, keystones, or strong interactors)\ldots are probably riskier to move than those whose role is largely redundant with other species." (citation omitted)).}

\footnote{351}{Id. ("Many ecosystems are not pristine because one or more species have been extirpated. In these cases, would it be acceptable to introduce a ‘climatic refugee’ that might fill the role of the extirpated species?"))}

\footnote{352}{Cf. Willis et al., supra note 7, at 48 (stating that butterfly species in a translocation experiment "were released into communities that contain species with which they already coexist elsewhere, so negative consequences of the translocations for other species were extremely unlikely.")}

\footnote{353}{See Richardson et al., supra note 5, at 9722.}

\footnote{354}{See Hunter, supra note 7, at 1357 (stating that human-dominated landscapes like a mine restoration site would be more acceptable as a target site for assisted migration than wilderness reserves).}

\footnote{355}{See Richardson et al., supra note 5, at 9722. For example, in general the more geographically isolated the site, the easier to contain any unforeseen harmful effects of a translocation. See Hunter, supra note 7, at 1357. However, a more geographically isolated site is also likely to consist of more unique biota and be more evolutionarily isolated (and thus potentially more vulnerable to introduced species). See id.}

\footnote{356}{Hunter, supra note 7, at 1357 ("[A]ll other things being equal, a species-rich ecosystem may be less likely to be disrupted by a translocation than a species-poor ecosystem.")}

\footnote{357}{For other possible criteria that I and others have articulated, see Richardson et al., supra note 5, at 9722.}
Nonetheless, these various factors do provide a basis for a preliminary standard for evaluating when to allow experimentation with assisted migration. Such an experimental standard would need to balance the substantial risks from intentional introductions identified in Section I.A with the necessity of initially developing knowledge and experience with the new strategy. Over time, in light of information obtained through experimental efforts, more refined standards tailored to particular contexts could and should be developed.

A justifiably cautious approach would initially restrict use of assisted migration to a narrow set of situations when, in light of the above-mentioned factors, there is sufficient certainty that the benefits of a translocation would plainly outweigh the costs. Specifically, such a provisional standard might restrict the translocation of a species to only those circumstances when, as compared to any management alternatives, there is substantial data that: (1) it is technically and economically feasible for the proposed transporter to move the target species to a particular site;\textsuperscript{358} (2) the species is at high risk of extinction in its current location and has substantial ecological value; (3) the species could be relatively easily removed or contained on the target site;\textsuperscript{359} (4) the introduction is unlikely to cause substantial harm to the proposed site; and (5) the proposed site is and will likely be compatible with the introduced population for a substantial period.\textsuperscript{360} Importantly, this standard would not consider whether the proposed site is within the native range of the species, except to the extent that it might bear upon the feasibility of translocation or the species' compatibility with candidate sites. Instead, it would focus on the value and compatibility of the candidate species and site at issue and the relative merit of translocation as compared to other potential management strategies.\textsuperscript{361}

Because this experimental standard would be limited to the translocation of endangered species, initial legal modifications could be restricted to the federal ESA and comparable state endangered species

\textsuperscript{358} For example, given their more limited mobility, plant species in general are likely to be easier and more cost-effective to transport and manage than animal species.

\textsuperscript{359} For example, in general terrestrial species are likely to be easier to manage post-translocation than marine species.

\textsuperscript{360} An even more restrictive regime might initially limit experimental assisted migration only to contexts in which the origin and receiving sites are federal land. Such a limitation would likely provide a less politically volatile setting, allow federal agencies to stay relatively in control of the undertaking, and channel all regulatory approval through section 7 of the ESA. See 16 U.S.C. § 1536(a)(2) (2006) (requiring all federal agencies to "consult" with the FWS to ensure that actions they carry out, fund, or authorize do not "jeopardize" the continued existence of listed species or "adversely modify" their critical habitat).

\textsuperscript{361} See Richardson et al., supra note 5, at 9722.
Accordingly, administration of this provisional standard—whether the performance of assisted migration directly or the authorization of its use through a permitting process—would likely be lodged in the Services and analogous state wildlife agencies. At the federal level, such a revision would include changing the ESA's provisions governing reintroductions under section 10(j) and section 10(a)(1)(A).\textsuperscript{363} Significantly, unlike the FWS regulations that interpret section 10(j), the proposed standard would not be linked to whether the proposed site is within the "probable historic range"\textsuperscript{364} of the species. Instead of restricting introductions of species outside their historic range to circumstances when "the primary habitat of the species has been unsuitably and irreversibly altered or destroyed,"\textsuperscript{365} the standard is focused primarily on the translocation's feasibility, the species' ecological significance, and its compatibility with future climatic conditions at a site.

Subsequent, more comprehensive modifications might involve federal legislation that amends federal invasive species law to regulate translocations of wildlife based on the feasibility of translocation, the species' ecological or social value, and the species' and target site's compatibility. Another alternative that focuses on federal agency activities might be to modify Executive Order 13,112,\textsuperscript{366} which regulates federal agency introductions, away from its focus on "alien" species toward an analysis of feasibility, the species' value, and compatibility with the target site. FWS might also encourage similar modifications by states to state wildlife management and invasive species laws.\textsuperscript{367}

Of course, the proposed precautionary standard could and should be adapted and improved after initial experimentation and subsequent events provide additional information. For example, depending on the success of

\textsuperscript{362} See supra notes 163-177 and accompanying text for a summary of state endangered species laws.

\textsuperscript{363} See supra notes 103-111, 178-193 and accompanying text. In addition, any proposed movement of a listed or non-listed species that would be carried out, funded, or authorized by a federal agency and subject to ESA section 7 could be subject to the same standard, including whether such movement is feasible, the value of the moved species, and its compatibility with the target site (including any effect on listed species at the site). A more extensive (and perhaps legislative) change to the ESA that seeks to augment federal regulation of the private movement of endangered plants might seek to clarify that the movement of listed plants would require an analysis of the movement's feasibility, the species' value, and its compatibility with the proposed relocation site.

\textsuperscript{364} 50 C.F.R. § 17.81(a) (2009).

\textsuperscript{365} Id.

\textsuperscript{366} 64 Fed. Reg. 6183 (Feb. 3, 1999); see supra notes 112-113 and accompanying text (discussing Executive Order 13,112).

\textsuperscript{367} For example, FWS could develop model state legislation for managing translocations, or perhaps leverage ESA section 6 state cooperative agreements that allow FWS to condition federal funding to state authorities pertaining to species conservation on non-federal lands. See 16 U.S.C. § 1535(c), (d) (2006).
pilot experiments and the harms to vulnerable ecosystems that emerge from climate change, regulators might consider removing the requirement of substantial ecological value. They might also expand the category of species to include not only endangered species but also populations that are otherwise in substantial decline. Alternatively, unsuccessful experiments might suggest that translocations of certain types of species should be further restricted. Yet again, increasingly severe detrimental effects from climate change on certain ecosystems (or even human populations) might suggest the expansion of translocation efforts from merely protecting vulnerable species to enhancing vulnerable candidate sites or advancing other social values.

C. An Adaptive Learning Infrastructure

Unfortunately, at present virtually any proposed assisted migration would be laden with considerable scientific uncertainty for each of the conditions offered in Section IV.B. Though some scientific data on the various ecological characteristics detailed above may be available for some species and sites, such information is nonexistent for most biota and locations. Given the projected acceleration in global climate change and risks to natural systems, resource managers and research ecologists should work toward generating the critical information that is lacking about the numerous complexities that confound assessments of the risks of assisted migration. In addition to research that directly bears on the multitude of characteristics of candidate species and sites for assisted migration mentioned above, research activities that would help reduce uncertainties include: (1) increased and improved localized climate data and localized climate modeling; (2) basic data collection inventorying and monitoring the current distribution and abundance of species; (3) increased and improved biogeographic range modeling to estimate future species distributions, in particular for at-risk species; and (4) the development of methods for integrating non-climate factors (such as competitions, mutualisms, and dispersal capacity) into range modeling. Such information would help inform decisions as to the appropriateness of assisted migration. Additionally, such data would reduce uncertainties and allow for a better assessment of the advisability of other possible strategies for helping to minimize the effects of climate change and other stressors on ecological systems. It would also provide information to better calibrate the appropriate standard for employing assisted migration as a natural resource management strategy.

368 As explained infra in Section V.C these factors also raise a variety of normative questions that are not solvable solely by reference to scientific information.

369 See McLachlan et al., supra note 6, at 300-01.
Still, the determination of whether assisted migration will be effective and useful will be case-specific, and the success of a translocation inevitably will be affected in part by circumstances that are difficult, if not impossible, to predict. Any number of subsequent unforeseen events might transform a hitherto beneficial translocation into a damaging one. As such, what is needed is a regulatory system that recognizes both that ecological systems are dynamic and that initial regulatory decisions regularly will be made on incomplete information. Particularly in light of global climate change, natural resource agencies like the FWS must be required to treat management as a long-term learning process of provisional decisions followed by monitoring, evaluation, and adaptation.\textsuperscript{370} To start with, natural resource agencies like the FWS must integrate information-gathering and decisionmaking processes that are focused on informing and improving the initial determination of whether the risks to a focal unit are sufficient to warrant assisted migration.

More broadly, legislatures and regulators must institute a comprehensive adaptive management and governance framework that seeks to cope with the inevitable uncertainty that comes from managing resources in light of limited data and shifting conditions. "Adaptive management" has been offered in the legal and scientific literature as a system for accounting for new information or changes in circumstances through long-term monitoring, reexamination, and possible modification of initial regulatory decisions.\textsuperscript{371} Increasingly, natural resource agencies are proposing the incorporation of adaptive management into the regulatory process, yet few of these programs have focused on providing the infrastructure or incentives for resource managers to manage uncertainty and learn through adaptive management.\textsuperscript{372}

As I have argued elsewhere, what is needed to manage the uncertain effects of climate change on natural systems is a more comprehensive learning infrastructure that promotes the systematic monitoring, assessment, and adjustment of discretionary agency decisions and agency personnel.\textsuperscript{373} Past experiments in adaptive management suggest that Congress must pay attention to the incentives of agency personnel,

\textsuperscript{370} See Camacho, supra note 80, at 39-40; Camacho, supra note 267, at 342-44, 351.
\textsuperscript{372} See Camacho, supra note 80, at 40-42, 47-48.
\textsuperscript{373} See id. at 49-50, 64-65.
encouraging and even requiring regular monitoring, assessment, and adjustment of management decisions and agency initiatives. In the context of assisted migration, this “adaptive governance” component would require agencies to not only monitor no-analog communities as they transform in response to climatic and other changes. It would also require these agencies to manage risks of harm after initial determinations on the propriety of assisted migration are made, and to integrate a process for regular adjustments of management decisions over time to account for new information or changed conditions.

To facilitate learning on a broader scale, Congress should also establish a network and clearinghouse for the collection and dissemination of information among natural resource managers, agencies, and the broader public. Importantly, such information should include not only scientific data pertinent to assisted migration but also the periodic assessments of management decisions and agency performance required through adaptive management. A number of federal agencies, including the United States Geological Survey, the National Oceanic and Atmospheric Administration, and the Environmental Protection Agency have started to assemble some scientific data and tools pertinent to climate change adaptation. However, these initiatives have not been linked with any rigorous attempt to develop and incorporate systematic information on the performance of management decisions, resource managers, and agencies. By coupling a publicly accessible information network with an adaptive governance methodology for assessing and adjusting decisions, Congress can help induce agencies like FWS tasked with managing dynamic ecosystems to learn throughout the governance process and better manage and reduce uncertainties from climate change over time.

At any rate, even if it were possible to provide robust scientific data on the many factors that shape whether an assisted migration is appropriate

374 See id. at 70-76.
375 Id. at 70.
376 See id. at 65-70.
378 The National Oceanic and Atmospheric Administration (NOAA) launched the NOAA Climate Services to gather and disseminate climate-related information and tools. See NOAA Climate Center, http://www.climate.gov (last visited Apr. 4, 2010).
379 The Environmental Protection Agency created the Climate Ready Estuaries (CRE) program, which includes an information portal to help estuaries and coastal programs prepare for the effects of climate change, as a supplement to its National Estuaries Program, a regional collaboration program for estuaries. See U.S. Environmental Protection Agency, Climate Ready Estuaries, http://www.epa.gov/cre/ (last visited May 4, 2010). For a detailed analysis of the CRE program, see Camacho, supra note 80, at 55-61.
380 See Camacho, supra note 80, at 55 n.313, 60-61.
for any particular candidate species and site, it is important to note that the
ultimate decision on whether to move a species into a new area will not be
possible solely by reference to objective scientific criteria or expertise.
Many of the relevant factors for assessing the use of assisted migration—
including an introduction's technical and economic feasibility; high risk of
extinction; substantial ecological value; substantial harm to the proposed
site; the site's compatibility with the species; substantial period; and
substantial data—are fraught with normative assumptions about the social
value of a particular species, location, or ecological function. Decisions on
the appropriate weight of each of these factors necessarily must be made
not only based on the likely compatibility of the species to site conditions
(and vice versa). They must also be made by reference to the broader social
value of the target species, the target site, and its constituents.381 Scientific
information will be vital in reducing uncertainty and minimizing the risk of
harm. However, as detailed in the next Part, the core questions regarding
when assisted migration might be an acceptable strategy for adapting to
climate change require a host of extended but vital public deliberations
that have not even begun.

V. The Future of Natural Resource Management

Assisted migration kindles and inflames a number of tensions that
exist in natural resource policy: protecting endangered species or native
biota; leaving natural systems alone or actively managing them; and
preserving resources or steering them to adapt to future climate
conditions. More importantly, assisted migration shows how existing
accommodations of these tensions in natural resource law are tilted
toward a static and dualist view of the natural world that is poorly suited
to deal with dynamic ecological systems. This becomes particularly
apparent and problematic in an era when global climate changes are
exerting a variety of accelerating pressures that are altering biotic
interactions worldwide.

In demonstrating these tensions and the limitations of existing natural
resource policy, assisted migration illustrates how climate change compels
a reassessment of three key features of modern American natural resource
governance. First, assisted migration demonstrates how climate change
inevitably compels a reassessment away from baseline goals that seek to
preserve or restore historical or existing conditions to a focus on
maximizing desirable future conditions—though the particular formulation
of such a goal for natural resource management is very much unresolved.
Second, while making clear that biotic interactions will change

381 See, e.g., Richardson et al., supra note 5, at 9722-23 (discussing social criteria
relevant to assessments of the feasibility and acceptability of assisted migration).
considerably with or without direct human involvement, climate change necessarily reshapes the primary unit to target for management away from individual species or even assemblages of species toward ecological processes. Yet again, concretely steering resource management toward such a focus remains elusive. Third, the swiftness of climate change demonstrates that distinctions previously made in natural resource policy between native and exotic, or between natural and introduced, are overly simplistic and anchored in the flawed notion that the world is inert. Public resource management must explore new management standards for determining what ecological conditions are desirable or acceptable. Each of these necessitates substantial further public discussions to ascertain the future of public natural resource policy—and thus the prospects for assisted migration.

A. Baseline Goals

The conflict over assisted migration shows that the goal of preserving or restoring resources to a historic baseline that currently dominates natural resource policy will be increasingly difficult if not impossible to sustain. More than ever, modern anthropogenic climate change emphasizes the necessity of actively managing for the future. Yet the particular shape of such an objective is far from clear. As such, climate change necessitates extensive public discussions and ultimately legislative guidance regarding what is valuable and important to the public about natural resources such as endangered species and existing biotic communities.

As explained in Subsection II.B.1, to varying degrees existing invasive species and natural resource management laws seek to promote the preservation or restoration of past historic conditions. Recognizing the limitations of the "natural stability" model of ecosystem dynamics upon which such laws were created, agencies were just beginning to try to integrate into management the shift in scientific knowledge toward a model that focuses on the complex but still manageable flux of ecosystems. With a warming climate predicted to create significant alterations in climatic conditions that will reshuffle species and utterly transform many ecosystems, anthropogenic climate change will likely require the abandonment of even this more nuanced form of stationarity. Ecologists are recognizing that finding a successor model

382 See Ruhl, supra note 281.
383 See Milly et al., supra note 279, at 573 ("In view of the magnitude and ubiquity of the hydroclimatic change apparently now under way, however, we assert that stationarity is dead and should no longer serve as a central, default assumption in water-resource risk assessment and planning.")
"is crucial for human adaptation to changing climate," through that search is just beginning to occur.

Similarly, natural resource management must be transformed away from a primary focus on preserving or restoring historical biotic assemblages. With significant alterations in climatic conditions anticipated for many ecosystems, preservation and restoration goals will be increasingly unsustainable. Accordingly, statutes like the National Park Service Organic Act and Wilderness Act that primarily seek to preserve historical conditions will need to be reconceived away from a strict fidelity to the past toward a greater focus on promoting desirable future conditions in light of climatic changes. For these and other statutes like the NFMA, ESA, and NWRSIA, key agency interpretations that prioritize preserving or restoring preexisting species and communities will need to be reshaped to allow and even facilitate the development of new biotic interactions.

Once natural resource management departs from a strict moral imperative of historic conditions, however, it becomes increasingly difficult to define or evaluate the desired endpoint. Although the preservationist goal may be simplistic and unrealistic, it is not difficult to understand why its bright-line approach has been influential. A historic baseline may never have been sustainable given the dynamism of ecological systems, but its relative simplicity was undoubtedly attractive. In contrast, a baseline that focuses on anticipating and seeking to meet desired future conditions is significantly more daunting and further exposes natural resource management to the vagaries of politics.

For conservation advocates, it is likely to be particularly disconcerting. Many interests in natural resources are not of the conservation variety, and a more forward-looking baseline that removes preservation as a primary goal increases opportunities for more tangible and more easily priced consumptive uses to be given precedence. To be sure, the economic value or yield of biota has been a prominent consideration in American public natural resource law and management even before the initial adoption of multiple-use policies, and it is likely

384 See id.
386 See supra notes 204-213 and accompanying text.
387 See, e.g., JAMES RASBAND, JAMES SALZMAN & MARK SQUILLACE, NATURAL RESOURCES LAW AND POLICY 651 (2004) ("Although different administrations have been more or less amenable to
to remain influential in resource management in the future. Yet deliberations that necessarily include evaluating the relative value of consumptive use and long-term conservation create sizeable risks for conservationists, particularly given the history of intense political pressure often wielded against natural resource conservation.\footnote{88}

Similarly, aesthetic judgments have played an important role in natural resource policy, whether in the management of endangered or invasive species,\footnote{89} national parks,\footnote{90} or other resources.\footnote{91} In the context of assisted migration, in real terms it is likely that the degree of affinity for a certain candidate endangered species will matter in decisions on whether assisted migration will be publicly accepted, as will the perceived charisma of biota that exists in a possible receiving ecosystem. Given the pressures on ecological resources likely to accompany climate change, the inclusion of such considerations in tradeoff decisions appears inevitable.

Destabilizing a foundational norm like historic preservation of course raises the risk of unintended consequences. Some might seek to exploit the demotion of historic preservation in natural resource law as a strategy for bypassing natural resource conservation values entirely. For example, some might propose introductions of organisms into new areas in contexts unrelated to endangered species or ecosystem conservation, such as for primarily recreational, agricultural, or economic purposes.\footnote{92} Of course, climate change's dislodging of traditional preservation and restoration as the core conservation objective does not make preserving or restoring resources completely immaterial in management decisions. As it has in the

\footnote{388} David A. Dana, *Existence Value and Federal Preservation Regulation*, 28 *Harv. Envtl. L. Rev.* 343, 373 (2004) ("One objection to the use of the political process as a measure of the relative weight of competing sets of preferences is that the political process may favor certain types of groups over others, and hence over-weigh certain sets of preferences relative to others.... If there is any skewing in the federal political process vis-à-vis natural resource preservation, however, it is in favor of the opponents of preservation.").

\footnote{389} See supra note 256 and accompanying text.


\footnote{391} See, e.g., E.T. McMahon, *The Point of a View*, 66 *Nat'l Parks* 26 (1992) ("The Highway Beautification Act, the National Historic Preservation Act, the Wilderness Act, the Wild and Scenic Rivers Act, and the National Environmental Policy Act all advance aesthetic interests.").

\footnote{392} Cf., e.g., Cole et al., supra note 16, at 42 (describing a proposal to replace existing non-native trout in the Bob Marshall Wilderness with better-adapted non-native trout for recreational purposes); Assisted Migration Adaptation Trial, http://www.for.gov.bc.ca/hre/lorgen/interior/AMAT.htm (last visited Feb. 19, 2010) (detailing research efforts in seed transplantation by the British Columbia Ministry of Forest and Range designed to help the agency revise their "species and seed source selection guidelines, helping to ensure maximum health and productivity of BC's planted forests well into the future").
past, the historic preservation or restoration of ecological systems may continue to serve important scientific, educational, and cultural values in particular cases.\textsuperscript{393}

Yet global climate change ensures that the costs of such benefits will continue to escalate. As climatic conditions shift, any conservation approach that endeavors to moderate use and development by tethering resource conservation to historic or current conditions will require increasingly interventionist strategies. By dedicating ever increasing management resources to preserving "native" resources in a given ecosystem that are incompatible with existing climate conditions, persisting in preservation will make conservation more administratively costly. More importantly, it will prevent the movement and protection of ecological resources that may be more compatible with the ecosystem's new abiotic conditions. As a result, historic preservation or restoration objectives are likely to contribute to the decline of ecological fitness for at least some landscapes.

Perhaps like many conservationists, I would argue for a particular focus on maximizing future ecosystem function or health over exclusively aesthetic, economic, and historic preservation considerations. Such a future-oriented focus would undoubtedly often look to sustaining or re-establishing the resilience, health, and adaptive capacity of an ecosystem. It might regularly seek to cultivate and enrich existing resources by using past conditions as a guide. However, its overriding focus would not be to revert to or maintain historic conditions, but rather to ensure that the ecosystem is sustainable, resilient, and healthy under future conditions.

Yet even limiting natural resource management decisions to evaluations of the relative importance to ecosystem function of the biological constituents at issue involves considerable subjective valuation. There is no clear, established understanding of what exactly ecosystem function or health means, and such evaluations inevitably involve determinations regarding which features of a biological system should be prioritized. Some may reasonably conclude that a particular bionetwork should be managed to maximize biomass, or some other metric of productivity.\textsuperscript{394} Others may reasonably place a greater emphasis on

\textsuperscript{393} See, e.g., Stephen T. Jackson & Richard J. Hobbs, \textit{Ecological Restoration in the Light of Ecological History}, 325 SCIENCE 567 (2009) (asserting that historic restoration efforts will remain valuable by providing important information about ecosystem structure and function and the efficacy of responses to disruptions). To the extent that preservation remains a goal, extensive public deliberation on what preservation or restoration means will be necessary. For example, it is unclear whether a preservation or restoration goal in a changing climate would require managers to mimic the past; mimic what would have happened to ecological systems without global climate change; or perhaps mimic what would have happened without human-induced dispersal barriers.

maximizing biodiversity. However, there are many different types of biodiversity (for example, genetic, species, and ecosystem diversity), and even in a particular form of diversity there may be different goals. For example, in the context of assisted migration, is the goal to create limited populations to prevent species extinction, or to broadly naturalize species into new ecological contexts? As climate change makes clear that an emphasis on keeping natural resources static is increasingly untenable, it demands increased scientific inquiry and debate about how to measure ecosystem function or health. It also necessitates an inclusive public discussion over the appropriate accommodation of these many unresolved economic, aesthetic, historic, and ecological values.

B. Focal Unit

Assisted migration also illustrates how climate change pits protecting endangered species against maintaining native ecosystems, further complicating debates over the appropriate focus for managing resources. The scale of projected global changes in climate makes even clearer that it will be impossible to save every ecosystem in its existing state or every endangered species in situ. But then what should public natural resource management try to save?

Accepting that ecosystems are dynamic is only a first step in a chain of confounding implementation issues that need to be publicly explored. Two interrelated difficulties include determining the appropriate biological unit on which to focus, and developing the criteria for deciding among potential types of that unit. The first challenge asks: Should managers focus on salvaging a particular genetic type, a species, a biotic assemblage of connected species, or an entire bionetwork? Even if a legislature or resource agency determines that assisted migration is acceptable, for example, it is not obvious what unit should be the focus of translocation efforts. Managing some of these foci may be infeasible with existing scientific knowledge, and it certainly has not been established which of them would be considered publicly acceptable.

Secondly, natural resource managers and conservation ecologists are increasingly referring to looming management efforts to help wildlife adapt to climate change as an exercise in triage. Thus, even if the

395 See, e.g., J.B. Ruhl, Working Both (Positivist) Ends Toward a New (Pragmatist) Middle in Environmental Law, 68 GEO. WASH. L. REV. 522, 542 (2000) (“Scientific research suggests that the concept of biological diversity, or biodiversity, is the key metric of ecosystem health.”).

396 See Kareiva et al., supra note 218, at 58-59 (recommending consideration of triage by natural resource agencies); Marris, supra note 348, at 152 (discussing increased acceptance by ecologists that species conservation under climate change will likely involve species triage).
appropriate focal unit were established, there is no agreement on what the criteria should be for deciding among particular types of that unit. For instance, if one were to focus only on species, it is still very unsettled what the criteria should be in deciding which species to focus on saving. Ecologists are just beginning to debate the appropriate basis for prioritizing species, with scholars alternatively advocating a concentration on the importance of a species to its ecosystem's function, its taxonomic distinctiveness, its future evolutionary potential, and simply prioritizing geographic areas.

Yet individual species are not the only units of possible interest. Prior experience under the federal ESA indicates that solely focusing on endangered species may be misguided, and there are other kinds of biodiversity (for example, genetic or ecosystem) that may be relevant to the health and stability of biological systems. For example, engaging in assisted migration to help a population of a species survive may lead to genetic mixing with another population, with potentially positive or negative consequences on fitness.

At the ecosystem scale, as detailed earlier, many scholars have emphasized the need to rely on ecosystem management, but identifying generally accepted, concrete features for managing ecosystems under global climate changes remains elusive. There is no general consensus regarding which ecosystem features managers should attempt to maintain, and which they should allow to transform. The past emphasis by some ecosystem management advocates on maintaining viable levels of native populations makes little sense as ecosystems become increasingly inhospitable to native biota and more amenable to non-natives.

In light of the limitations of an exclusive focus either on preventing species extinction or maintaining preexisting ecosystems, proponents of ecosystem-based management who identify ecosystem patterns and processes as the important focus for management are persuasive. Given the dynamic character of natural systems that is particularly apparent with global climate change, a focus on ecological processes makes intuitive sense. Yet there has been little agreement on what exactly a process focus

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397 See Walker, supra note 346 (advocating the prioritization of species that provide unique and necessary ecosystem functions).
398 See id. at 21 (describing triage based on the genetic uniqueness of the species).
399 See Marris, supra note 348, at 152-53.
400 See supra note 272 and accompanying text.
401 See Walker, supra note 346, at 19 (describing many types of biodiversity).
402 See McLachlan et al., supra note 6, at 301.
403 See supra notes 313-324 and accompanying text.
404 Grumbine, supra note 216, at 31.
would entail. Drawing on the growing literature on ecosystem services, such an approach might emphasize seeking to ensure that certain prioritized functions provided by an existing ecosystem (such as nutrient cycling, water cleaning, waste decomposition, human food provision, or carbon sequestration) continue to occur in future climatic conditions. Under such an approach, the particular species or abiotic ecosystem process that provided the function might not be particularly significant. If so, the resource manager's task might be to attempt to predict and translocate biota that might perform valuable functions in existing resource areas in future climatic conditions. Yet even under this approach a public discussion would still need to occur regarding which ecological functions or services should be prioritized.

Many have also emphasized the need to maximize ecosystem resilience as an important focus of climate change adaptation efforts, with some even promoting it as the foundational goal. Though in the abstract such an emphasis seems quite reasonable, it is not even clear how resilience could be measured or managed. Some assert that "common sense indicates that healthier ecosystems will generally be more resilient to disturbances," but nonetheless recognize that this is an assumption. Furthermore, as stated earlier, managing for ecosystem health is not an objective endeavor; promoting resilience through ecosystem health could include managing to protect at least some portion of all ecosystem components, only foundational species, or perhaps only species deemed to be socially valuable. Moreover, though promoting resilience may help prevent the worst harms from climate change to the health of ecosystems, a focus on managing for resilience does not take into account that the

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406 See Susan Herrod Julius, Jordan M. West & Geoffrey M. Blake, *Introduction*, in *U.S. CLIMATE CHANGE SCI. PROGRAM*, supra note 218, at 2 (defining resilience as "the amount of change or disturbance that a system can absorb without undergoing a fundamental shift to a different set of processes and structures"); see also Kareiva et al., supra note 218, at 14 ("Resilience is the ability of a system to return to its initial state and function in spite of some major perturbation.").

407 See, e.g., Julius et al., supra note 406, at 2 (stating that "the goal of adaptation is to reduce the risk of adverse environmental outcomes through activities that increase the resilience of ecological systems to climate change").

408 See, e.g., Craig, supra note 385, at 40.

409 See Kareiva et al., supra note 218, at 15 ("Our understanding of specific resilience factors for particular systems is sparse, making managing for resilience currently more an art than a science.").

410 Id. at 14 ("Activities that promote overall ecosystem health, whether they are restorative (e.g., planting trees, captive breeding, and reintroduction) or protective (e.g., restrictive of destructive uses) will tend to build resilience.").

411 See id. at 15-16.
projected scope and severity of climate change may require a choice between ecosystem components.\footnote{Cf. Camacho, supra note 80, at 13 ("[T]he projected scope and severity of global anthropogenic climate change threatens to compromise the fundamental resilience and existence of many ecosystems." (citation omitted)).} Focusing on resilience simply does not provide direction for actually making tradeoff decisions among species in a particular changing ecosystem.

In short, as one accepts that climate conditions and thus biotic interactions are changing, there is no settled approach in either natural resource law or conservation science regarding what features of ecological systems managers should focus on to promote desirable and minimize undesirable change. Owning up to the fact that human activity has shaped and will continue to influence ecological systems only begins the analysis and deliberation. Much more scientific investigation is needed on which foci are possible, and there must be a broader public consideration of which foci and criteria for deciding among biological units are normatively desirable in different circumstances.

C. Management Standards

Lastly, assisted migration demonstrates the flaw in relying on absolute dichotomies such as native/exotic and natural/artificial as core features of managing biological systems under global climate change. Though such complete dualism has the advantage of simplicity, it is neither accurate nor helpful in deliberations over how to manage and choose among resources as ecological systems change with climatic conditions. Dedicating substantial resources to preserving and restoring a particular biological unit because it existed at one point in time in an ecosystem makes little sense if climatic conditions make the landscape inhospitable to that unit. Similarly, what is the ethical or scientific justification for prohibiting or removing any organism simply because it never existed in a particular location, especially if that organism is now well-matched with the location due to changes in climatic conditions?

Whether managers engage in assisted migration or not, ecosystems will still be invaded and change, and some species will likely go extinct. Describing a biological unit as "native" will really be useful only as a historical description. In short, even if the native/exotic and natural/artificial distinctions made sense when ecological change was less dramatic,\footnote{Some suggest that the native/exotic and natural/artificial distinctions were not meaningful even before global climate change. See N. Brown, Re-Defining Native Woodland, 70 FORESTRY 191 (1997) (stating that the term "native" is ambiguous and arbitrary); David M. Lodge & Kristin Shrader-Frechette, Nonindigenous Species: Ecological Explanation, Environmental Ethics, 251} it is difficult to see why they should be a central feature of natural resource law and management in a future with global warming.
However, natural resource law is only just beginning to explore what should be the replacement standard for evaluating potential management strategies, and such deliberations will be critical to evaluating potential applications of assisted migration. For one, reliable scientific information relevant to such discussions is sorely lacking. In the context of assisted migration, there is little data available (and few existing tools for obtaining such data) on (1) current species distributions, (2) future distributions under changes in climatic conditions, (3) the projected effect of biotic interactions on species ranges, or (4) the genetic consequences of translocations on source and destination populations. Because of these many sources of uncertainty, perhaps the reversibility of an introduction or other adaptation strategy should be an important factor in evaluating its potential use.

Yet, as illustrated in the assisted migration context, further ecological research alone will not solve this problem. Thorough public discussions and guidance about what to value in ecosystems are critical for evaluating adaptation strategies like assisted migration. A shift away from nativity necessitates a reshaping of the definitions and management approaches pertaining to invasive species, endangered species, and wildlife in general to focus on the compatibility of biota with projected ecological, and perhaps other “desirable,” conditions in particular locations.

Necessarily, refocusing natural resource management toward future conditions opens up a suite of new normative questions about the criteria for making management decisions. Taking the example of assisted migration, if a public or private party translocates a non-listed species into areas outside the species’ probable historic range, what is the relevant range of the species for purposes of deciding whether to identify the species as endangered? Similarly, who should be liable for an assisted migration that has collateral effects on other lands? Under what circumstances should a landowner be permitted to destroy land in a listed species’ historic range if she can prove that the land will not be suitable for the species in the near or distant future? Whether the provisional standard for engaging in assisted migration proposed in Part IV is adopted or not, any decision on whether to engage in assisted migration will involve implied or express normative assumptions and tradeoffs about the social value and compatibility of the various natural resources in question.

and Public Policy, 17 CONSERVATION BIOLOGY 31, 33 (2003) ("[S]pecies invasions are natural and... the very definition of ‘non-indigenous’ sometimes hinges on what time frame is being considered."); Charles R. Warren, Perspectives on the “Alien” Versus “Native” Species Debate: A Critique of Concepts, Language and Practice, 31 PROGRESS HUM. GEOGRAPHY 427, 431 (2007) ("No species is inherently alien, but only with respect to a particular environment at a particular moment.").

414 See McLachlan et al., supra note 6, at 300-01.
Such normative judgments will also be encountered in the remaking of federal and state invasive species laws. Indeed, similar to this Article's proposed provisional standard for assisted migration, some have already advocated for the express integration of a compatibility criterion in invasive species law, calling for a focus on a species' harmfulness regardless of whether the species is native or not. Of course, evaluations of how damaging a species may be or other considerations of a species' suitability for a particular location are not solely ecological but also cultural. Accordingly, such assessments necessitate the involvement of the general public and their representatives to help decide the future of natural resources.

Conclusion

Though this Article provides a preliminary framework for assessing both when to allow and how to manage experimentation with assisted migration, it more importantly explains how climate change reveals a host of value questions that remain unexplored in natural resource law and policy. The resolution of these questions will shape not only determinations regarding the acceptability of assisted migration, but more broadly the future of natural resource management. Perhaps the most important question confronting natural resource policy in this era of global climate change is therefore who should decide and be responsible for the future of natural resources.

Under the existing patchwork of natural resource laws that predate anthropogenic climate change, a multitude of scattered and uncoordinated private and public entities have the default authority or license to engage in assisted migration efforts, with likely serious consequences for the future of the world's biological and human systems. Should any one person or regulatory authority be allowed to decide the fate of a species or ecosystem? Is there anything wrong with thousands of people taking on the role of Johnny Appleseed for their favorite species? Who should be

415 *See, e.g.,* Warren, *supra* note 413, at 437 ("[A]n increasingly common proposal is that a species' potential for causing harm in a particular place and time may be the most useful, honest and ethically defensible criterion for guiding conservation choices." (citations omitted)); *id.* at 442 ("[T]he justification for controlling and eliminating invasive species should not be their time, mode and place of origin but their potential for causing damage.").

416 *See* Lodge & Shrader-Frechette, *supra* note 413, at 33 ("[A]n ethically defensible conclusion is that both native species and nonindigenous species should be managed with respect to what is both humanly and ecologically desirable."); Warren, *supra* note 413, at 437 ("[T]he merit of a species should perhaps be judged... against pragmatic criteria such as its value... to human and/or biological communities.").

417 *See generally* W.D. Haley, *Johnny Appleseed: A Pioneer Hero*, 43 HARPER’S NEW MONTHLY MAG. 830 (1871) (providing an account of Jonathan Chapman, a pioneer who introduced apple trees to parts of Illinois, Indiana, and Ohio), available at
responsible for the collateral effects from such introductions, such as any harm to agriculture? Should one jurisdiction have input on (or even authority to prevent) another’s consideration of whether to engage in a translocation that will have collateral effects on the first? Assisted migration makes evident that climate change is prompting a reassessment of not only to what end societies protect environmental resources, but also what processes we rely on to begin formulating answers.

Similarly, climate change challenges the role of scientific expertise and public participation in natural resource decisions. As climate change necessitates conservation management in the face of exceptional uncertainty, there will be strong inclinations to turn to scientific, economic, or legal authorities to make the difficult choices on how to shape the future of the world’s natural resources. Removing the constraint of historical continuity could potentially give unelected regulators substantially more discretion to fashion technocratic solutions to natural resource decisions. However, as demonstrated in debates over assisted migration, the resolution of when an adaptation policy is advantageous is ultimately not a technocratic question of feasibility; at its core it is an ethical concern.

The uncertainty that exists in evaluating strategies for adapting to climate change is not merely scientific; there is considerable uncertainty regarding what should be the priorities and guiding principles for managing natural resources. Without the ability to rely on a historic baseline for ascertaining regulatory goals, ecologists arguably have less of a claim to expertise. Scientists can and should provide vital data regarding the projected effects of environmental change, the tradeoffs that are involved in resource management decisions, and the potential consequences of alternative choices. They can and should make recommendations, argue for them in the public domain, and defend the ethical bases of their conclusions. However, these recommendations are merely inputs into the democratic process. The ultimate decision regarding the management of common resources in a democratic system is necessarily a public one, and thus inevitably ethical and political.

Accordingly, the key endeavor in natural resource governance must be improving the design of natural resource decisionmaking processes to inform not only natural resource managers but also the public at large. The learning infrastructure advocated earlier in this Article and

http://digital.library.cornell.edu/cgi/t/text/pageviewer-idx?c=harp;cc=harp;rgn=full%20text;idno=harp00043-6;view=image;seq=00840;node=harp00043-6%3A1.

418 See Camacho, supra note 80, at 10-13 (discussing the many forms of uncertainty raised by climate change for natural resource governance).

419 See supra notes 370-380 and accompanying text.
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elsewhere—seeking to couple adaptive governance with an intergovernmental information-sharing network—is certainly aimed at directly advising natural resource managers and cultivating agency learning. However, this learning infrastructure is intended not only to induce agency self-reflection on the effectiveness of management strategies, but also to promote information flow and dialogue among jurisdictions and between managers and the public.

Mandating that each authority monitor and periodically evaluate management strategies and that such assessments are made publicly available encourages interjurisdictional information sharing and discourse. Such a network allows resource managers and stakeholders to serve as sources of external pressure on regulators to engage in effective resource management. More importantly, it can help to reduce the collective action problems and impediments to collaborative learning characteristic of the existing fragmented natural resource management system.

In summary, a regulatory framework that fosters open and transparent access, debate, and deliberation can promote agency accountability to democratic representatives and the general public, and more informed public deliberation and action with regard to the management tradeoffs that must be made in devising goals and standards for natural resource management.

Though developing such institutions and processes will be far from easy, such a pursuit unquestionably should be the focus of natural resource law in a world of rapid climate change. The prior account of a pristine and untouched nature may be nearing its end. However, the opportunity to help foster biotic and human communities that truly integrate humanity's collective self-interest in resource conservation and duties of stewardship has really just begun.

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420 See Camacho, supra note 80, at 64-76; Camacho, supra note 267, at 347-57.
421 See Camacho, supra note 80, at 68.
422 Id.
423 See id. at 65, 68.